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Tunnel-Sections on the Canadian Pacific Railway.

We are indebted to Mr. THOS. KENNARD THOMSON, of the Dominion Bridge Co., for the following data on the tunnel sections used on the Canadian Pacific Railway, and Mr. THOMSON on his part acknowledges his indebtedness, for uniform kindness and assistance, to Mr. JAMES ROSS, who was General Manager of Construction in the "Rockies," to Mr. WALTER A. DOANE, who was in charge of the designing office, and to Mr. G. H. DUGGAN, who was associated with Mr. DOANE and is now with the Dominion Bridge Co.:—

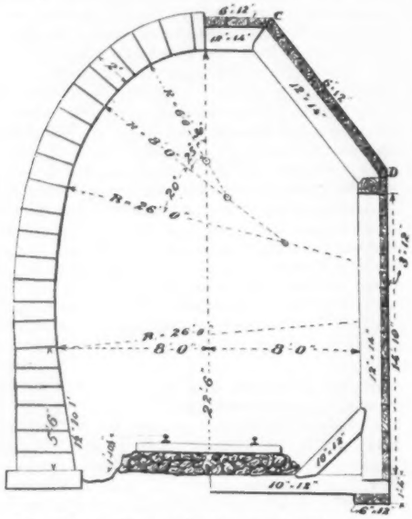


Fig. 1. Tunnel Section for Earth.

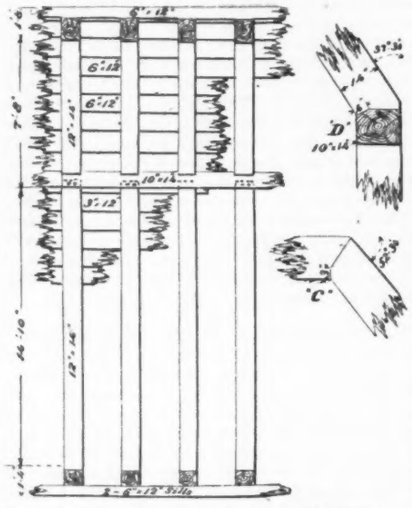


Fig. 2. Tunnel Section for Earth; Longitudinal Section.

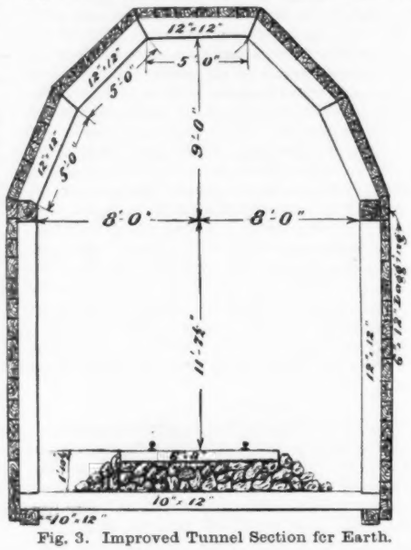


Fig. 3. Improved Tunnel Section for Earth.

Tunnel Sections; Canadian Pacific Railway.

Two different sections were used for earth or mud tunnels, that shown in Figs. 1 and 2 and the improved section, Fig. 3. A bad feature in the section Fig 1. was the inclined brace at the bottom of the tunnel, as was proven in the Corres mud tunnel. In this tunnel the soil was very loose and the joints *D* were forced out (from the track) and the vertical posts were ripped straight up from the notch made for the inclined brace. This occurred just after the completion of the tunnel and before the soil had time to settle. It was remedied by building another section inside of the first, which though it reduced the width of the tunnel, still allowed trains to pass through, although it did not give the clearance required by the Government. It was also found better to have the top arch in five rather than in three pieces as was the case in Fig. 1

Another obviously bad feature, but one for which necessary haste would not permit a remedy, was the style of the longitudinal wall-plate, the end of which is shown at the joint *D*. It is evident that the timbers would be much firmer if the top segment pieces rested directly on the vertical posts, instead of having the longitudinal wall-plates intervening.

Fig. 4 shows the section adopted for loose rock and shale. Excavation was always commenced at the head or top of the tunnel. The wall-plates were first put in place and as soon as possible the top-segment timbers were put in and 6 in. lagging was rammed in between the roof and the timbers. When the heading had been thus pushed forward about 20 ft., work was commenced on the bench and the vertical posts put under the wall-plates one by one.

This method permitted two gangs to work at each end. In a few cases oval drifts, about 6 ft. wide, were made from the sides to allow men to work from the center as well as the ends. Some of the engineers gave the contractors the exact level and position for each wall-plate and sill as they were put in, thus requiring them to be in the tunnel almost all of the time occupied in excavation; but other engineers deemed it sufficient to give the center line only.

All of these tunnels have a slight inclination from the center towards each end for drainage purposes. As the tunnels were generally short, no difficulty was experienced from foul air. Fig. 5, the cross-section for solid rock, will explain itself. In Fig. 1 the area of the timber-line was 418.5 sq. ft., making 15.5 cu. yds. of excavation per lineal foot, and 680 ft. B. M. of timber per lineal foot. In Fig. 4, with posts 5 ft. centers, the timber per lineal foot was 430 ft. B. M., and the rock excavation equalled 14.84 cu. yds. In the solid rock section, Fig. 5, the contents equalled 11.67 cu. yds. per lineal foot.

The Sewerage of East Orange, N. J.

The agitation for the sewerage of East Orange, N. J., commenced under the leadership of the Township Improvement Co. in 1883, has ended in a novel system of treatment just completed. The plans were drawn up in May, 1886, by Mr. C. PH. BASSETT, and the work has been under his supervision to this time.

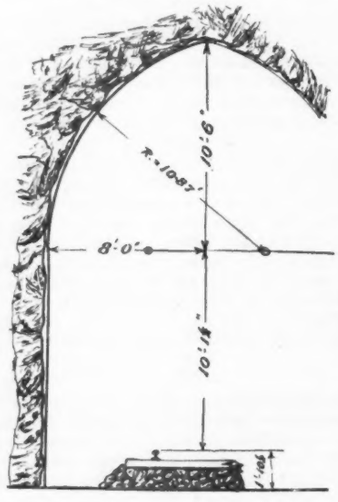


Fig. 5. Tunnel Section for Solid Rock.

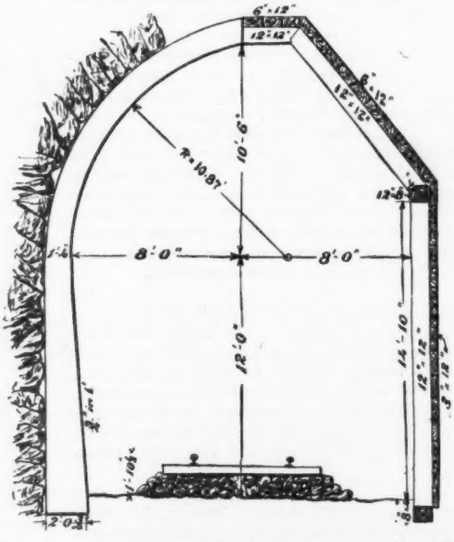


Fig. 4. Tunnel Section for Loose Rock and Shale.

Four main trunk sewers have been laid in the natural valleys; these mains vary from 12 in. to 24 in. in diameter and at each street intersection they are fed by smaller laterals with which the house connections are made. At the extreme end of each lateral is a flush-tank discharging 300 galls. of water every 24 hours into the lateral. And for the clearance of any obstruction, that cannot be removed by flushing, manholes are put in the entire line at intervals of 300 ft apart, and through these can be operated a jointed rod provided with a scraper.

About one-fifth of the township lies too low to conduct its drainage to the main outfall by gravity alone. Consequently a separate system has been planned for this section leading to a central collecting well, and from this well the sewage is forced by an Otto sewage pump through a line of iron pipe and into the main system. With the exception of this forcing main, all the pipe lines are built of vitrified drain-pipe with cemented joints. The diameter of the laterals connecting with the house-drains is 8-in. and that of the main lines varies from 10-ins. to 24 ins. according to service required.

The treatment works cover 14 acres at Greenwood Avenue lying on a tributary of the Passaic river. The buildings are very handsome for work of this character. The tank-house is divided by a longitudinal wall into two settling tanks each 36 ft. wide by 112 ft. long, and each of these is subdivided by transverse walls into three compartments. These two main tanks are used alternately, one being cleaned while the other is in use. The sewage enters the tank through a series of interlacing projections from the side of the sewer, and at this point the chemical ingredients are added and thoroughly mixed with it. The sewage then passes to the settling tanks, the solids settling to the bottom and the now harmless liquid flowing out through channels over the surface of the adjoining grounds. The flow of sewage is then changed to the other tank and the solid matter is siphoned into cast-iron receivers and mixed with milk of lime. When the

receivers are full, their contents are forced into coarse canvas bags arranged between a series of corrugated disks which can be tightly bound together by a screw. A pressure of about 150 lbs. per sq. in. reduces the solids to a moist firm cake, which is packed in barrels and sold as a fertilizer. The chemicals used in treatment are essentially milk of lime and sulphate of aluminum.

This sewage treatment plant is planned for the service of a population of 60,000, or four times the present population. To cover the contemplated territory 60 miles of sewer will be required. At present the system contains 27 miles of pipe and the cost has been about $370,000. Of this amount the pipe lines cost $310,000 and the remainder was expended in the disposal and treatment plant.

The Proper Relation to Each Other of the Sections of Railway Wheels and Rails.

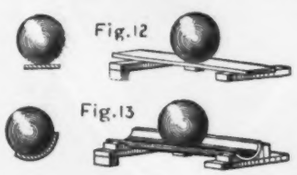
[Preliminary Report of the Committee on this subject to the American Society of Civil Engineers.]

(*Concluded from page 381*).

THE THEORY OF THE QUESTION.

The wheel has been not unreasonably claimed as the greatest of human inventions, and the essence of the wheel is that its theoretical bearing surface shall be a mathematical line or point, affording no area of bearing surface whatever. In practice this is not strictly the case, owing to the elastic compressibility of the surface, but the bearing surface is also very small, nor can it be increased to advantage by making either wheel or bearing surface more compressible.

To such bearing surfaces the ordinary compression moduli of the text-books have no application whatever. These have been derived from experiments upon prisms, which have the same bearing surface as their greatest section or nearly so, and which fail from flowage or distortion long before the individual molecules of the material are seriously injured. To apply these constants to the bearing surface of spheres, or of cylinders laid on their side, or to draw the conclusion that pressures exceeding them are therefore dangerous or destructive, is entirely unwarranted. No attempt has ever been made, nor can there well be, to determine constants for such round bodies per square inch, but on the knife-



edges of large scales, which have an angle of some 75° only, and must be and remain practically unworn and uninjured, a load of 7,000 lbs. per lineal inch of edge (3½ tons) is considered good practice, or nearly as much as rests on a wheel. If we allow for the difference between this sharp edge, which sustains a continuous load, and the flat tread of a wheel which sustains a load for an instant only, it would warrant an enormous load per square inch of bearing surface. In good bridge practice it is considered entirely safe to load steel rollers rolling on steel up to the equivalent of 10,000 lbs. per lineal inch for a 33-in. wheel.

The sphere also has a much less bearing surface than a cylinder of the same diameter, for the same load, yet cannon ball rollers render excellent service in bridge work, nor are your Committee aware that they have ever been claimed to be more destructive to the bearing surfaces.

In Figs. 12 and 13 we have two opposite conditions for a rolling sphere, and certainly it will be admitted that Fig. 12 shows the best conditions for least friction and wear, although the bearing surface is much less.

Your Committee are not clear that, even if we consider the top bearing only, where no question of consequent rubbing friction comes in, it can be stated without many allowances that increase of bearing surface is in itself an advantage. They cannot regard it as by any means self-evident that less wear would result if each rail and wheel-tread were made a foot wide or even 6 ins. wide. They are rather disposed to believe that it would be entirely disadvantageous.

To see why this is so, we must consider what causes rail and wheel wear. It is far from true that, as has sometimes been carelessly assumed, the only wear, or the chief wear, results from crushing, either on curves or tangents. There are these three causes for wear:

First.—Direct sliding of wheel on rail, such as is generally admitted to cause substantially all the extra curve wear.

Second.—Molecular interlocking of the fibres, which is the cause of the wheels revolving instead of sliding, and wears and bends the fibres on their side.

Third.—Direct crushing and disintegration of the fibres from the effect of the insistent weight.

Of these three causes, your Committee are decidedly of opinion that the last is by much the least important of all, and they are led to this conclusion by the fact that it seems easy to account for as much wear as occurs by the first two alone. The wear from the first two is most certainly not inversely as area, but comes nearer to being directly as the area (the total pressure being the same) if brake experiments and others may be trusted. Take

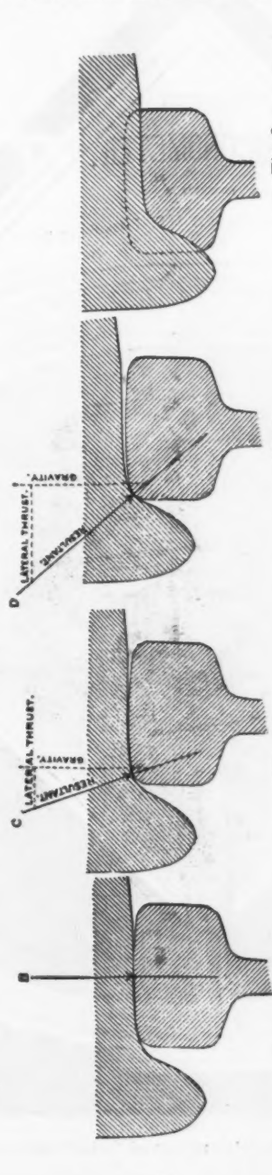


Fig. 8. Flange acted on by little or no lateral force, but adapted to rail as its form permits without such force.

Fig. 9. Flange acted on by a moderate lateral force, as by impacts or oscillation on tangents. (The line C gives the resultant line of pressure perpendicular to the bearing surfaces in contact.)

Fig. 10. Flange impelled against the rail by a strong lateral thrust, as on outside rail of curves. (The line D gives the line of pressure, still perpendicular to bearing surfaces in contact. The wheel rises as shown until they becomes so.)

Fig. 11. Worn outside rail on curves, having the bearing surfaces worn to conform to each other, as in Fig. 2. [p. 341.]

direct sliding wear on a tangent, for example. Whenever the wheels are of different diameter, direct sliding occurs. It takes a difference in diameter of less than 3-100 of an inch $\left(\frac{33 \times 56\frac{1}{4}}{5730 \times 12} = .0271 \text{ ins.}\right)$ to cause as much slipping as on a 1 degree curve. If the truck is out of square, there is constant slipping, its amount depending on the curve in which the truck tends to run. If the flange impinges on either side, there is further slipping, both laterally and because of the change in diameter of the wheels. All three of these causes are continually acting and often to an aggravated degree.

The resulting resistance and abrasion comes from the interlocking of the fibres, and as such interlocking is the only source of propelling power, it must go on for the most part without directly crushing down the fibres, but simply by sliding past them.

In all such friction the wear is certainly very largely increased by having large areas and many fibres in contact. In brake shoes, for example, it is well known that large shoes have greater holding power than small, with the same pressure. So long as the wheel revolves, the comparatively small frictional surface below affords as much resistance as the larger brake surface, but the moment the wheel stops, the smaller surface below causes vastly less friction than the larger one, and your Committee cannot doubt that this is chiefly because there are a less number of fibres exposed to tearing abrasion, and consequently less work done on them. They see no reason why this should not likewise be the case with all the sliding which takes place from causes noted on the top of the rail. In ordinary vehicles, running on ordinary roads, it is not considered advantageous to increase the width of tires more than is necessary to prevent sinking into the surface. While this analogy is an imperfect one, your Committee cannot admit that larger contact of rolling surfaces, and certainly not of rubbing surfaces, results in any decrease of wear, and they see no reason for anxious efforts to accomplish what has never yet been accomplished for any length of time, a bearing surface for the tread extending over the entire top of the rail. This is on the assumption that the rolling contact is of a cylinder of uniform diameter. When we include the corner of the rail and a crowning top, resulting in a different radius of rotation, and hence introduce rubbing friction, the case becomes still clearer, as will next be considered.

In Fig. 2 [ENG. NEWS p. 341] (reproduced from Fig. 45 of Mr. FORNEY's paper, showing the form of rail and flange therein recommended) the tread at *B* has a radius of 16½ ins. and the lower contact point at *A* a radius of about 17 ins. As wear proceeds the latter radius will become still longer. As the greater load rests at or near to *B* the wheel will roll on that point, and at all points of contact having a different radius *A* or *C*, will partly roll and partly slide or grind continuously.

A simple computation will show that a difference of $\frac{1}{16}$-in. in the radius at any point $\left(\frac{4.9 \times 16.5}{5730}\right)$ will cause that point to slide as much as the outside (or inside) wheels must on a 1° curve. Hence, the point *A* is sliding on the rail as fast as the outside wheel would on a 35° curve, and the whole flange contact from *A* to *B*, as fast as the outside wheel would on a 15° to 17° curve. This must inevitably produce extra grinding wear, and as there is the same reaction of rail against wheel on curves of all radius (viz., that necessary to continuously slide the wheels laterally so as to change their direction of motion), it will have a tendency to approximate the outside rail-wear on all curves to that on 15° to 17° curves.

On the other hand, there can be no question that there is a certain minimum corner radius beyond which the corner cannot be sharpened without destructive wear. To produce an absolutely square section, for example, so that the diagonals of a square section will measure what theory requires, is impossible even in the laboratory. The corners become sharp as a razor, and even the pressure of the finger nail, not to speak of a car wheel, will abrade them so as to materially change the diagonal. A car wheel would produce the same effect with a corner of quite appreciable radius, and the very least radius which is ever to be found in old rails under any condition (see Fig. 7) is about ⅛-in., nor do your Committee suppose that any one would maintain that rails should be rolled to less than twice that radius.

Between the two extreme limits of (1) an absolutely sharp corner, and (2) the same corner radius as that of the flange fillet, the conditions with new rails are represented by Figs. 8, 9 and 10, Fig. 11 representing the conditions which finally obtain with all rails on the outside of curves. As to how closely it is desirable to have the rail corner under these conditions approximate to the fillet radius, the question appears to stand thus:

When the wheel from any cause tends to run against the rail and is restrained by the flange, the forces acting are (1) the vertical component of gravity; (2) the lateral component from the lateral thrust, whatever it is; and (3) the resultant of these three forces, acting at an angle more or less oblique. Under these conditions the laws of mechanics determine what must take place. The wheel will mount until it rolls on the corner with the bearing surfaces normal to the resultant line of pressure, and will then remain in that position. Whatever the respective corner radii, so long as they differ at all, the theoretical line of contact will be a point, and to the extent that compression of the material expands this point into a line, the bearing surfaces will still be normal to the pressure. As the wheel is not revolving in the plane of this resultant, there will still be a certain trifling amount of sliding friction, but the question is:

1. Will there be more or less grinding friction or abrasion under the conditions of Fig. 10 than under those of Fig. 11? It certainly seems to your Committee that there should be greatly less, and the rate of abrasion should increase when the conditions of Fig. 11 are attained and the two radii correspond, as the statistical facts above given seem to show.

2. Is it desirable that the corner radii in Figs. 9 and 10 should be nearly alike, or differ considerably?

So far as rubbing friction only is concerned there will be less wear if they differ considerably; so far as crushing action is concerned, there will be less as they approach

each other. As a whole, it seems probable to your Committee that the very minimum rate may be when the fillet and rail radii are nearly alike, but not quite; but that they should be therefore made so in the beginning appears more doubtful for the following reasons:

The evidence seems to be that under all working conditions the rate of rail-wear is very much less before the conditions of Fig. 11 are reached than afterwards. It is therefore desirable to postpone the attainment of such conditions as much as possible. But if the radii be made nearly alike in the beginning, we have but little metal to wear away before the conditions of Fig. 11 are attained. In proportion as the corner is originally sharper we have more. That is to say, if we take the total metal available for wear in the head at 10 pounds per yard or 1 sq. in., by using for the corner radius.

¼ in.	in place of	⅝ in.	we add	14.08%	to wearing section.
"	"	½	"	8.05	" "
"	"	⅜	"	3.35	" "

If the preceding indications are correct as to this being very nearly the metal of slowest wear in the rail head this is a serious loss, much larger than the above percentages alone indicate, and the question of which radius will give the lowest rate of wear in the new rail is less important than which gives the most metal to be worn away before the conditions of Fig. 11 obtain.

The same reasoning, if sound, applies conversely to the fillet radius of flange. The larger this radius, the longer will it take to wear away enough metal to bring about the conditions of Fig. 11. The most usual fillet radius some years ago was ¾-in., but ⅝-in. has lately been made standard by the Master Car Builders' Association, for the supposed purpose of approximating more nearly to the form of the rail-head, with some admitted disadvantage in manufacturing, because the smaller the radius the more difficult it is to get a perfect chill in the fillet. If the preceding deductions are correct, a ¾-in. radius is rather o be preferred for all reasons, but there is no particular necessity for having any single standard radius, either for rail or wheel.

The preceding report is submitted for discussion, as before stated, in order that all errors therein may be pointed out, and all available additional evidence brought forward before the Committee attempt to formulate a report giving final conclusions, which they hope to be able to do very briefly.

Respectfully submitted,

H. STANLEY GOODWIN,
A. M. WELLINGTON,
SAMUEL REA,
GEORGE S. MORISON,
THOMAS RODD,
JAMES ARCHBALD,
S. M. FELTON, JR.,
} *Committee.*

The report is concluded by seven large tables giving the data summarized in the report, and by a considerable body of correspondence from railway officials and others. Those interested in the subject and desiring to discuss the report can obtain copies by application to this journal. Discussions are invited by the committee from all engineers and manufacturers, whether members of the Society or not.

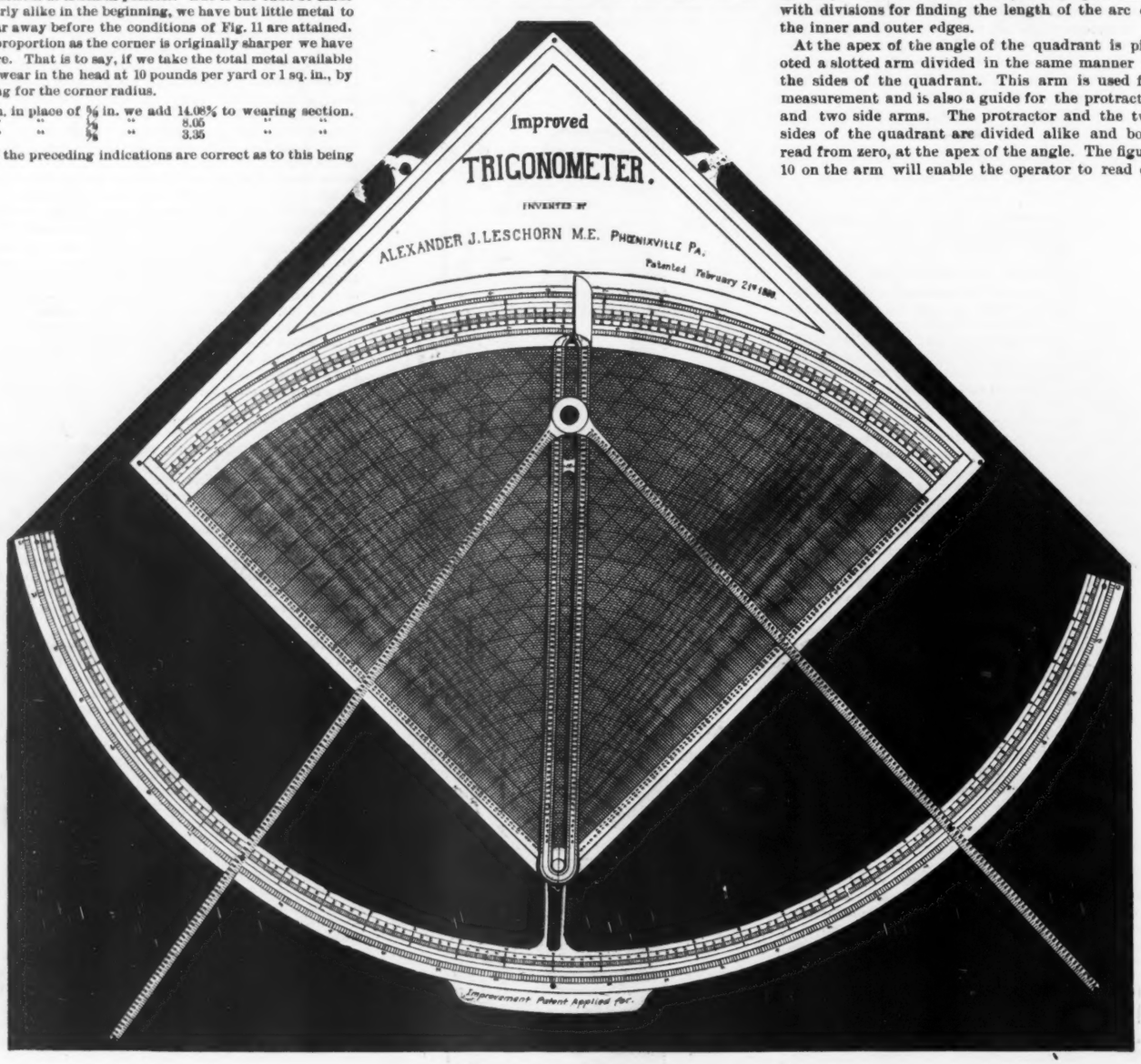


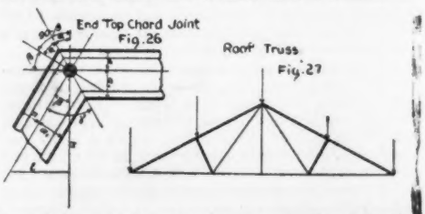
Fig. 1. Leschorn's Improved Trigonometer.

THE JERSEY CITY ELEVATED TRACKS of the Pennsylvania R. R. work on which was started last week, do not in any degree interfere with the Harsimus Cove elevated road, which is now being built, and which when completed will be used exclusively for freight purposes. "Nearly *three hundred* persons it is stated by an officer of the company, are killed or injured every year in this short run from the ferry to Bergen Cut. To defend the suits brought costs a large sum; then, too, a large amount is spent on flagmen. The wages of these men, who will no longer be needed, will more than pay the interest on the cost of the road."

An Improved Trigonometer.

The instrument here illustrated is an improved trigonometer invented by Mr. A. P. LESCHORN, engineer with the Phœnix Bridge Co. This calculating machine consists of a square plate, subdivided into quadrants of concentric circles connected by intersecting straight lines forming squares (Fig. 1). A protractor encloses the system of quadrants, with divisions for finding the length of the arc on the inner and outer edges.

At the apex of the angle of the quadrant is pivoted a slotted arm divided in the same manner as the sides of the quadrant. This arm is used for measurement and is also a guide for the protractor and two side arms. The protractor and the two sides of the quadrant are divided alike and both read from zero, at the apex of the angle. The figure 10 on the arm will enable the operator to read off length without looking at the intersection point. The two side arms are divided into a number of points sufficient to read off the longest distances and to rest on the protractor also.



Applications of the Trigonometer to Truss Work.

All trigonometrical functions can be found at one setting; i. e.: angle, radius, tangent, cotangent, sine, cosine, versed sine, secant, cosecant, etc. The length of any arc can also be found by setting the arm on any given angle, then read the numb

indicated by arm, multiply by the radius and divide by 10 : or

$$\frac{x \times radius}{10} = length\ of\ arc.$$

In a similar manner and by one movement only, the length and angles of a trapezium may be found. And the distances used in graphical computation can be read off with this instrument, instead of using compass and scale. The units may be assumed in inches, feet, millimeters, square feet or inches, cubic feet or inches, etc. Truss problems may likewise be solved in the manner indicated in the diagrams.

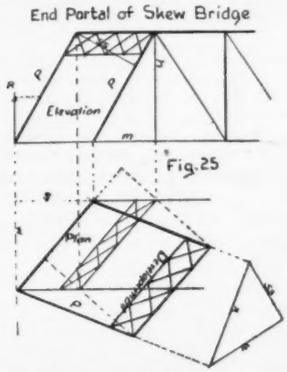


Fig. 25

Application of the Trigonometer to Bridge Work.

The small scale of Fig. 1 and the multiplicity of diagrams required, prevent a more detailed description of the operation of this trigonometer. But the principles involved are simple, and any reader seeking further light can obtain it from the inventor at the address given.

Electric Railways.

The following is a summary of the new street railway business which the Thomson-Houston Electric Co., of Boston, has now in hand:

Omaha, Neb. — The electric railway between Omaha, Neb., and Council Bluffs, Ia., has been opened for traffic and is in successful operation. The road is 9 miles in length and is at present equipped with 16 motor cars and 16 cars without motors, each motor car hauling one of the others. The cars were built by the Pullman Palace Car Co., and are connected by the vestibule device, in use for the first time here on street railway cars; this arrangement increasing the carrying capacity of the trains. Although the motors work well in either direction, a loop is made at either end of the track, so as to keep the motor always in front. This road opens a new means of rapid transit between the two cities, the residents having been previously compelled to travel by special trains on the Union Pacific Railroad, which ran once an hour, and upon which a fare of 25 cts, was charged. The fares upon the new line have been reduced to the usual street railway rates, but a speed equivalent to that of the steam road is made over a large portion of the track between Council Bluffs and the Missouri river bridge. This bridge is 3,000 ft. long, and was built in connection with the rapid transit scheme, the company having spent about $500,000 upon it. The line is one of the finest of its class. The overhead construction is neat and simple and there is no unpleasant noise from the motors.

Wichita, Kan.—The new electric railway has recently been put in operation and is working successfully; its traffic and receipts are satisfactory. An experiment made with another electric system some time ago was not successful, and that system was abandoned, but the new line is hoped to give renewed confidence in electric traction.

Lynn, Mass.—The electrical equipment of a portion of the Lynn & Boston road, through the thickly settled part of the city will be put in operation shortly. The road has many curves, grades as high as 12 per cent., and in its construction many difficulties were met with and successfully overcome.

Ansonia, Conn.—The Derby Horse Ry. Co., operated on the Van Depoele electric system, will add Thomson-Houston apparatus to its equipment.

Syracuse, N. Y.—The Third Ward Street Ry. Co. will open its electric line shortly.

Des Moines, Ia.—The electrical equipment for the Broad Gauge Street Ry. Co. is nearly completed. Manager TEACHOUT is well satisfied with the construction and plant.

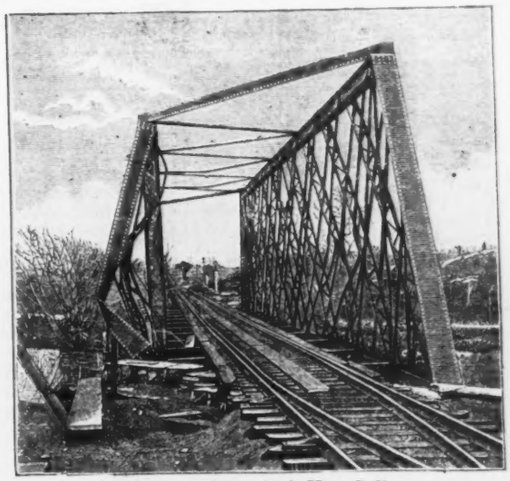
Topeka, Kan.—Work is progressing rapidly on the installation of the plant for the Rapid Transit Ry. This road will be 14 miles long, being the longest electric railway in the world.

Alliance, O.—Work is to be pushed on the electric railway, and it is expected to have it in operation in a few weeks.

North Adams, Mass.—The electrical equipment of the Hoosac Valley Street Ry., which it had been intended to defer until next year, will probably be completed this season.

A Bridge Which Did Not Collapse.

Mr. GEORGE H. THOMSON, Bridge Engineer of the New York Central & Hudson River Railroad, has recently contributed to the British Association a paper on "Mechanical Pathology, Considered in its Relation to Bridge Design," or in more precise language, on American bridge failures, from which we take the accompanying illustration. We regret that Mr. THOMSON contributed a paper on American bridge failures to the *British* Association (which he did by request of Mr. BAKER) instead of to the Am. Soc. C. E., where it would undoubtedly have attracted much attention. The primary purpose of the paper is to set forth the advantages of riveted bridge construction as compared with pin connections, a purpose with which we have a good deal of sympathy as respects ordinary bridges of the smaller spans. The pin connection is an admirable and distinctively American device, which in its proper field is highly meritorious; but its use has been pushed much too far for true economy and real safety in applying it to multitudes of such short spans as that which we illustrate, where such a blow as is pictured against the end post and some of the interior rods would inevitably have caused the collapse of the structure; whereas the stiffer riveted structure, it will be seen, did not even settle badly on the other side.



A Bridge Which Did Not Collapse.

Seneca River Bridge; Auburn Branch, New York Central & Hudson River R. R. Damaged, Aug. 24, 1873.

This type of construction, however, has been and is very rarely used in English bridge practice, even on structures where it well might be used, and therefore a paper pointing out to Englishmen the objections to it is very much like carrying coals to Newcastle, while the probable effect of the paper on American practice has been largely nullified by its appearance in foreign publications which few American engineers ever see, and fewer still look to for light as to how to improve American practice.

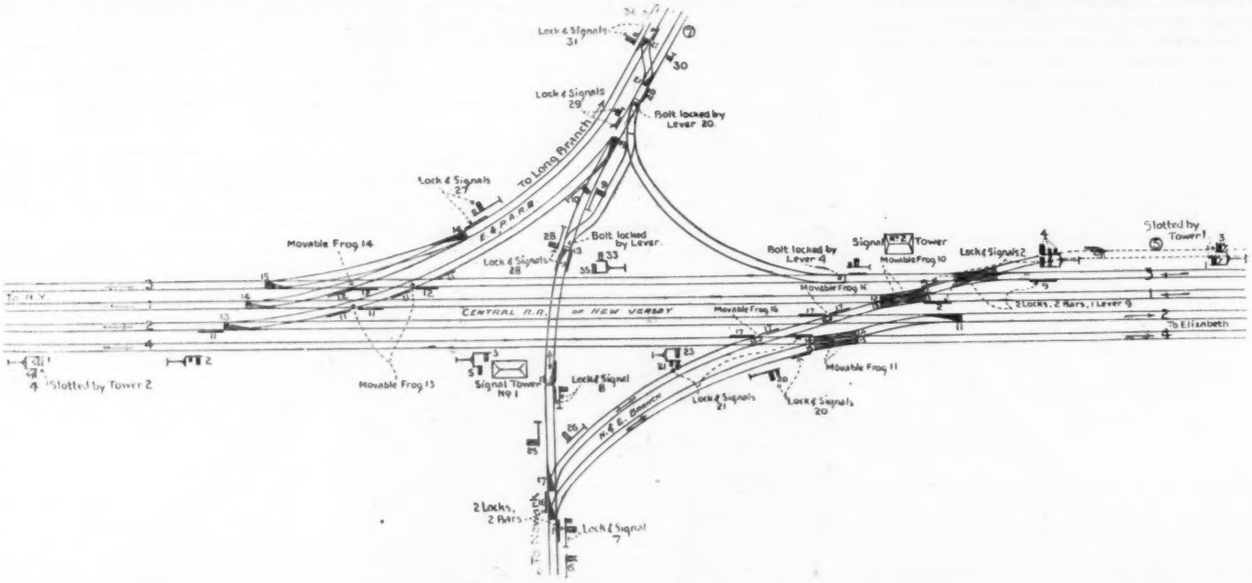
As was to be expected, the English technical journals have taken very kindly to the information contained in the paper. *Engineering* has been adorned for several issues with an eruption of views of "American Bridge Disasters", supplementing those accompanying the paper by 6 or 8 from the column of this paper, to which *Engineering* is heartily welcome, although we strongly suspect that its motive in reproducing them (as well as in giving such prominence to the paper) has been quite different from ours, and not wholly disconnected with a desire to instil into the mind of the gentle and guileless Colonist a conviction that the only really, truly good bridge-builders are "our builders at 'ome, you know." Whatever the motive, however, the single view which we in turn reproduce from *Engineering* is calculated to be an object lesson of great value to American practice and as such we reproduce it.

The discussion of the paper was quite brief, few of the audience probably, knowing anything about bridges. The summary of *Engineering*, however contains some interesting points. We italicize some striking features. It says :

> "It is much to be regretted that so valuable a contribution to engineering science as that of Mr. THOMSON should not have been brought forward under more favorable auspices, so that it might have given rise to a complete and full discussion. When a distinguished American engineer comes forward and deals so freely with a subject on which he might well be excused for showing some reserve, it is a pity his English fellow-workers *cannot profit to the full by the opportunity thus afforded to them.* A good discussion on this paper should have been a leading feature of the meeting of the section, and had English bridge designers and constructors been as frank as Mr. THOMSON, we should have found that there was a good deal to learn on both sides.
>
> Mr. WILLIAM ANDERSON, who occupied the chair in the absence of the President, referred to the great advantage of having a paper from an American engineer of such note as Mr. THOMSON. *It was a satisfaction to English engineers to know that they had, even if intuitively, adopted those principles of bridge construction which were now shown to be necessary to safety.* In former years he had been connected with the construction of bridges, but he had not had any work of the kind pass through his hands for a long time. He was surprised to hear that the weight allowed per foot was 2 tons, as 1 ton was considered enough in earlier days.
>
> Mr. BEAUMONT said that it was quite an unexpected thing to find an American engineer coming forward to admit that American bridge construction was not as good as that followed in England. This had been for a long time past a point of controversy between the representatives of the two countries. If these bridges which failed in the United States had been in England they would not have failed. *One of the chief American papers had a standing paragraph, "The bridge failures this week are"—so many. Sometimes they were more and sometimes less, ranging, perhaps, between three and ten;* and yet Americans were annoyed if we, in England, say that bridge failures are frequent across the Atlantic.
>
> Mr. BEAUMONT is not the first to attempt to make capital out of our feeble efforts to collect full records of the failures of engineering structures, and we fear he will not be the last. We have only to say, however, as we have said before, that the failures on 150,000 miles of road are naturally somewhat more numerous than on 18,000, especially when one includes a vast amount of small wooden structures on which nearly all the failures occur, while the other has none. If some of the English journals were to take equal pains to collect similar records on English built lines, they would, to our knowledge, be able likewise to make out very considerable lists, as the late failure of a high iron bridge in Mexico in a flood will bear witness, to which we recall no American precedent.
>
> Mr. BENJ. BAKER, who read the paper, concluded the discussion as follows, somewhat overrating, we think, the danger of Mr. THOMSON from his colleagues because he has seen fit to express his opinion :
>
> It had been asked why the paper was sent over to England, and the answer was simply because he had asked for it. Mr. THOMSON was one of the most prominent authorities on the science of bridge construction in America, *and no doubt he would have a warm time with his colleagues when they came to read what he had written.* The speaker wished to mention one fact. Reference had been made to English engineers and United States engineers. Now engineers looked on themselves as engineers, and did not much consider whether they were English or American, for they claimed an interest in all that was done by the brotherhood on whichever side of the Atlantic it might be. The question of nationality did not come in so far as the engineering aspect of the question was concerned; there was, in fact, no national feeling. When an American spoke of the Institution of Civil Engineers he meant the English institution, recognising in it the parent society of engineers all over the world. If he wanted to refer to the American Institution he called it the American Institution. It is a good thing that the bond of good fellowship and scientific interest should be strong enough to overcome narrow and senseless jealousies. Patriotism is a great virtue, but few things are more absurd than a mistaken application of its principles.
>
> A vote of thanks being proposed by the President was carried by acclamation.

The Elizabethport Switch Signal Station.

The statement is frequently made that it is absolutely impossible for those in charge of a modern interlocking switch and signal plant, whether from carelessness, ignorance, or malice, to so arrange the switches and signals as to cause a collision. The purpose in the following description of the mechanical appliances employed in this arrangement, is to demonstrate the truthfulness of this statement; and we have selected the Elizabethport station on the New Jersey Central, recently put in by the Union Switch & Signal Co.



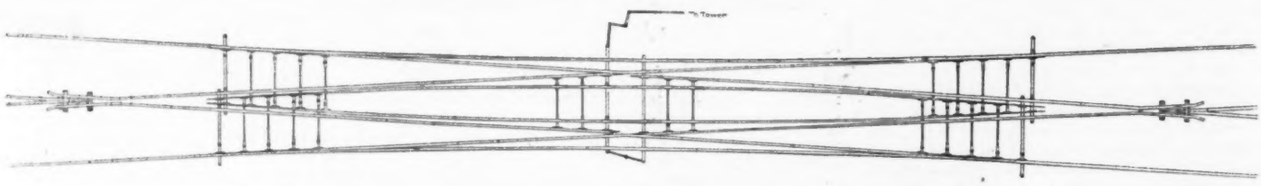
Elizabethport Switch Signal Station; General Plan.

At Elizabethport the Long Branch and Newark branches leave the main line. In addition there is one right angle crossing connecting the Newark and Long Branch lines and a curve connecting the main line with the Long Branch. A yard now being laid out further complicates matters. The main line has four tracks, the Long Branch two, and the Newark one.

All signals when in their normal position with the arms horizontal signify danger, and a train must not pass the signal until the arm is dropped at an angle of about 60°. This is the fundamental principle of the system, since the arm cannot be dropped to permit the train to approach unless the switches in that particular track are in their proper position. For instance, a through train on the main line approaching the Long Branch turnout from the east cannot be signalled properly if the switch is set for the Branch; neither will a train for the Branch receive its own signal to approach unless the switch is set for it. With the main line open, the signal for the Branch train cannot be displayed, neither can the latter be displayed until the turnout is open. It is not in the power of the operator to falsely signal trains, for the simple reason that the opening of a switch locks all signals in their danger position, except the one informing the engineer that that switch is open, and when that switch is closed its signal is locked in the normal position. The devices by means of which this is accomplished are extremely simple in construction, although the system as a whole appears confusing merely from the multiplicity of like parts,

The switches and locks are operated by levers in the tower through the medium of 1-in. gas pipe and bell-crank levers; the signals are set by a lever pulling a wire, and are returned to danger position by a back wire. All movements are performed by either a direct pull or push, no reliance whatever being placed upon either spring or gravity arrangements.

The levers in the two towers, the location of which is shown on the accompaning map of the tracks, are numbered to correspond with the switches and signals they control. The tracks are also numbered, the west-bound bearing even and the east-bound uneven numerals. Flagmen stationed beyond or outside of the system notify the operator by a bell code of the approach of a train, the track it is on and the track it is destined for. When the operator receives the signal 2.7, he knows the train is from the east on the main line and is going to Long Branch on track 7, he then sets the switches and signals accordingly. Should he fail to distinguish the taps distinctly, he can ask for their repetition or can refuse to do anything, when the train will be stopped by the danger position of the first red signal met.



Elizabethport Signal Station; Arrangement and Movement for Double Slip Point Switch.

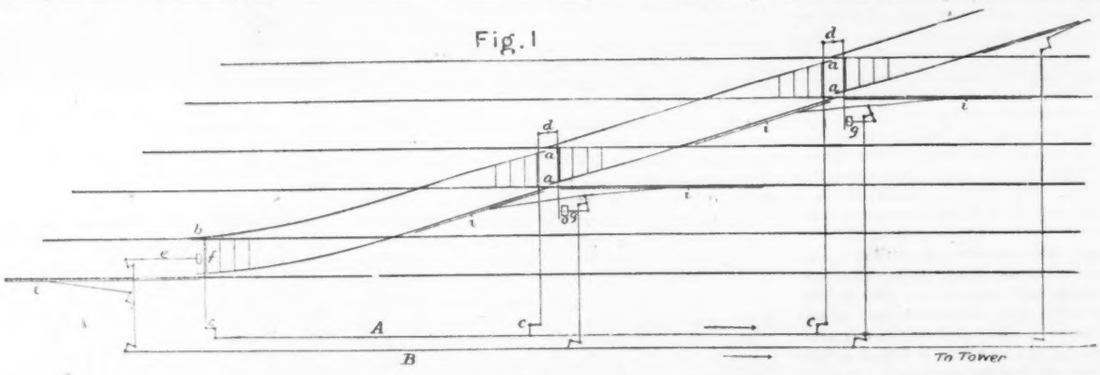


Fig. 1. Arrangement of Tracks, Long Branch Turnout.

To alter the position of the switches and signals, an unchangeable order must be followed. The switch is first shifted; then the detector bars and locks are moved (both by one lever), and finally the signals indicating the change in the track is dis-

played by pulling a third lever. To return the track to its original position this order is reversed, the signal being first brought to its normal or danger position. Should the operator pull off the signal and neglect to replace the switch, no harm

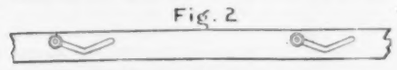


Fig. 2. Detector Bar.

could be done, as it would be impossible to drop any other signal except the one showing that the switch is open.

Fig. 1 shows one track of the Long Branch turnout and its connections. The movement of the rod *A* in the direction of the arrow will open the switch *b*, and the movable frogs *a a* through the bell crank levers *cc* and the cross bars *dd*. The movement of the rod *B* in the direction of its arrow will lock the switch by the rod *e*, connected with the front rod *f* of

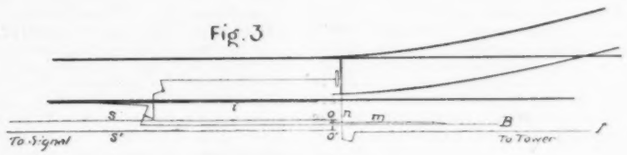
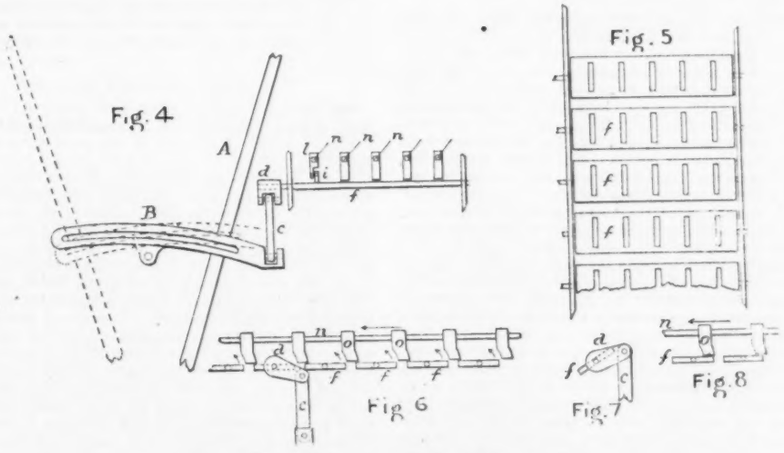


Fig. 3. Hook-Gear.

the switch, and will also lock the movable frogs by means of the bars *gg*, and will shift the detector bars *ii*. The detector bar, Fig. 2 is a flat piece of iron movably bolted to the outside of the rail adjoining the switch by bolts passing through angular slots. The top of the detector bar is flush with the top of the rail. It is apparent that, by reason of the form and position of the slots, the detector bar cannot be moved while a train is passing over the switch, and as the detector bar is longer than the distance between the trucks of the longest passenger car it cannot be moved between the wheels. As the rod *A* is locked by the movement of the rod *B* it is plain that the switch cannot be shifted during the passage of a train.

The hook gear, Fig. 3, serves to select the proper signal according to the position of the switch. The rod *A* operates the switch and the rod *B* locks the switch and moves the detector bar *i*. United to the rod *B* is the rod *m* which is joined near its free end to the switch rod *n* so that it will move as the switch is moved. The extremity of the rod *m* is formed into a loop adapted to engage either of hooks *o o'* on the signal rods *s s'*. As the switch is placed in the drawing, the movement of the rod *A* would, by the hook *o* entering the loop, display the signal indicating that the main line is clear. The opening of the switch would engage the loop with the hook *o'* when the signal for that route would be displayed.

The operating levers are divided nearly equally between two towers, one situated nearly opposite the depot and the other about 100 yds. west on the opposite side of the track. Here we find the interlocking apparatus by which one lever locks one, or several others. The most important details of the gear are shown in the drawing. A stud projecting from the lever enters the slot in the rocker link *B*, which is so mounted as to be rocked by the movement of the lever. One end of the link is prolonged a short distance beyond the slot and is formed with a recess to receive the lower end of a connecting rod *c*, whose upper end joins the pin of the crank *d*. The two joints of the connecting rod are universal. The crank is rigidly secured to the extended shaft of the so-called "flop" *f*, which is a rectangular casting formed with slots as shown in the plan view Fig. 5. The flops are journaled in a suitable frame. When the lever is moved to the position indicated by the dotted lines in Fig. 4, the crank *d* and its flop *f* will be in the position shown in Fig. 7. Upon that side of the flop which moves upward is a projection *i* engaging with a lug *l* on the driving rod *n*, the connection being so formed that the turning of the flop will move the locking bar *n* longitudinally. On the locking bars are bolted the dogs *o o* which of course move with it. When the dogs are in the position shown in Fig. 6 any of the levers can be thrown as the dogs will not interfere with the turning of the flops. But when the locking bars are removed so that the dogs rest directly over the upward moving sides of the flops, as in Fig. 8, the levers cannot be thrown as the flops are held by the dogs. The operation of the gear and purposes it serves are now evident. The dogs can be so adjusted that the throwing of one lever and the movement of its flops will lock any desired levers. The various combinations required by the switches, locks and signals can be easily secured.

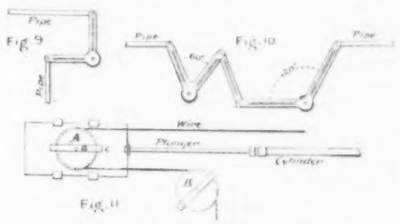


Figs. 4, 5, 6, 7, 8. Operating Levers, Etc.

On the main line each way from the towers are "home" and "distant" signals. The latter are only used for main line or straight running to aid fast running, and cannot be displayed unless the line is clear throughout. The home signals inform the engineer of the condition of the track. The distant signals must of necessity be operated from *both* towers, the lever in either one of which may be thrown first. The wire setting the distant signal passes through both towers and in each is connected with a lever. Neither lever alone will remove the signal owing to the slack in the wire which is taken up by the first lever moved, thereby allowing the second lever to do the work. This construction insures the safety of the track as far as both towers are concerned because the levers are locked by any open switches and the signal cannot then be displayed. It also prevents confusion and danger as either operator can hold the train should his part of the track not be ready.

In the right angle crossing, at each side of the main track, is a derailing switch designed to derail a train should it approach the crossing while the signals are at danger. Alongside of the main line at the crossing is a signal, working with the switch, which cannot be set clear unless the switch is closed.

In long lines of pipes, such as those here used, it is essential to provide means for taking up expansion and contraction. The compensator shown in Fig. 9 will do this when (and only when) it can be placed in the middle of the line. It consists of a right angle bell crank lever having arms of equal length, to the ends of which the pipe is joined. This device will



Figs. 9, 10, 11. Compensator.

only act as a compensator when arranged as shown in the drawing. A compensator or lazy jack which can be used in any part of the line is shown in Fig. 10. It is composed of two equal armed bell-cranks, one of 60° and the other of 120°. The adjoining arms are united by a connecting link while the pipe is joined to the other arms. Undue slack in the wires is taken up by turn-buckles at the towers. Expansion and contraction are compensated for by the device represented in Fig. 11. The wires pass around a nest of wheels *A* mounted on a common shaft held by a bracket *a* to the plate *c* which is free to move in guides. The wire then passes around a second nest of wheels *B* held in an immovable bracket. To the plate *c* is secured a plunger which passes through a stuffing box and enters a cylinder filled with petroleum or glycerine. The different rates of expansion and contraction of the wire line and the liquid act to counterbalance each other.

The Chilian Railway Concession.

We are indebted to Col. S. H. LOCKETT, with Col. N. B. LORD, one of the commission on the part of the American syndicate to negotiate this concession, for the following notes on surrounding conditions and for an abstract of the terms of the concession itself :—

Col. LOCKETT says that after some time spent in ineffectual efforts with the Minister of Public Works, Col. LORD, the Chief of Commission, adopted the policy of dealing strictly with the President of the Republic, Senor BALMACEDA, with the results already made public. The President is described as a man of broad information, and strong character and possessing a quick, keen and clear insight into business matters. The negotiations progressed favorably from the beginning, but with annoying delays resulting from the closing events of a busy session of Congress, and particularly from the national holiday of Sept. 10—the Fourth of July of the Chilinos—which is as patriotically celebrated as is the corresponding event in North America. But as already announced, the contract was finally approved at an extra session of Congress on Oct. 19.

This contract is for the construction of all the lines of railway mentioned in the list published in ENG. NEWS of Nov. 10, except No. 3, namely, the line from Tomé to Cauquenes and Parral. The survey of this line was not yet completed, or rather a change in the line had made a new survey necessary. It will undoubtedly be included in the work to be done by the North and South America Construction Co, as will be in all probability several other projected lines, also several other important works of internal improvement contemplated by the Government. Of those, however more anon.

The principal points of the contract between the Chilian Government and the North and South American Construction Company are as follows: The construction of the ten lines of railroad com-

plete: their complete equipment with locomotives, rolling stock of all kinds, stations, turn tables, tanks telegraph lines, etc., to be done in accordance with plans and specifications of the Chilian engineers for a lump sum of £3,542,000, English money. Lines Nos. 5, 6, 7 and 10 of the list already printed, to be finished in two years from signing of the contract; lines 2, 4, 8, 9 and 11 to be finished in three years, and the southern line from Victoria to Valdivia and Osorno in five years.

The bridges are to be of the American type of pin-connected trusses. This is a new departure in Chili. The English type of lattice riveted truss being the prevailing style of iron or steel bridges.

The bulk sums bid on the different lines to be subject to changes which Government may make in the location or length of lines. Price lists for monthly payments to be made out, based upon engineer's specifications and estimates of quantities and the sums named in the contractor's proposal.

Payments to be made for each month's work on Government Engineer's estimate on or before the 8th. of the following month. A bond of one million dollars to be deposited to the order of the Chilian Government as a guarantee of good faith by the contractors. The usual retained percentages in sums of $100,000 are to be invested in Chili bonds, or placed in bank at interest to the credit of the contractor, at his own option. Retained percentages are to be returned to contractor on the completion of 50 mile sections of the long line, and on completion of one half of the short lines.

The contractor is to have the use of 1000 to 1500 soldiers, as guards and laborers, at 40 per cent advance on their pay, if they are desired. The contractor to have a war ship or government transport to move laborers from one part of coast to another, if needed. The contractor to have the privilege of importing 1000 artisans and 6000 laborers, the Government to allow passage money.

Free passage is granted over all government lines now in operation for contractors, officers, men, tools, provisions and materials; also admission free of duty of all tools, provisions and material to be used in construction. A forfeit of an agreed small sum per kilometer per month on the value of all parts of roads not completed in specified time is agreed upon. This contract is subject to interpretation and modifications by mutual consent.

Annexed to the contract, and forming a part of it, are the plans and specifications and general conditions, for the construction of the works, for the classification and quality of materials, for the supervision and inspection and acceptance of work by Government engineers, etc. These general specifications and conditions are similar to what any engineer would draw up as a protection to his principals, and it would be a work of supererogation even to give a synopsis of them.

In conclusion a few words are added concerning the corps of engineers of the Chilian Government. In addition to their military corps they have what we very much need in the United States, a corps of Civil Engineers. This corps is under the administration of the Minister of Public Works. Its chief is Senor Don DOMINGO SANTA MARIA, officially designated as Director of Public Works. The corps is divided into sections, namely: That of railway construction; that of railway operation; that of common roads; that of irrigation and drainage; that of potable water. The only one having any dealings with the American syndicate is the first, of which the Chief is Senor Don BENJAMIN VIVANCO, a courteous gentleman and an able engineer.

Prospects of the Grand TrunkRailway System as Seen by its President.

The address of President Sir HENRY W. TYLER, of the Grand Trunk Railway Company, at the semi-annual stockholders' meeting held in London on Oct. 30, contains a most interesting statement of the impressions obtained by an English capitalist from an examination of the trunk line railway situation. During the past summer President TYLER made a personal inspection of the lines of the Grand Trunk system and also traveled quite extensively over the Western railway systems. His minute account of the plans and schemes of the management in working to secure competitive traffic and outgeneral their rivals sound strangely frank, accustomed as we are to the American practice of keeping matters of general policy a profound secret. But as is well known, a shareholders' meeting in England is a very different affair from a stockholders' meeting on this side of the Atlantic. And in the respect that the typical English shareholder is interested in the management of his property, while the typical American stockholder, in a good many companies at least, holds his stock for purposes quite apart from any prospect of dividends, it must be conceded that our practice on this side of the water cannot be commended.

We have space only for condensed extracts from the address, as given in *Herepath's Journal* of Nov. 3.

THE DULUTH, SOUTH SHORE & ATLANTIC.

I went to the Sault Ste. Marie, and saw the bridge which has been constructed there—and then over a line of which you have heard a good deal, and which has been the subject of contention, and from which it was stated that we had been cut off—the line from the Sault Ste. Marie to Duluth. It is quite true that the friends of the Canadian Pacific, by means of a large sum of money, have for the moment obtained control, for what it is worth, of that line; but we have not yet suffered in any respect from that occurrence. It is a question how far that line will be able to do very well in the immediate future. We have time before us, and we shall have opportunities, to take advantage in the future of what may happen in that direction.

THE GRAND TRUNK'S TRAFFIC.

The results of the past half year have been disappointing and unsatisfactory, both in themselves and as compared with the corresponding half year of 1887. There was a decrease of gross receipts of $639,586, and a net decrease of $427,410. The net receipts for the half year were $2,502,190.

The suburban traffic has been growing, and our officers have increased the passenger trains, or maintained the passenger train service, as much as was justified by the circumstances, or required in the face of the competition to which the company is more and more subjected. They are obliged to do more than they otherwise would do by the amount of competition they meet with, but they have been very careful in so adjusting the passenger train service as to meet the competition, and at the same time to work as economically as possible.

The harvest of last autumn, though abundant in the Northwest, was very deficient in those regions of Canada and the United States from which we draw our supplies. When there is less to carry there is always the greater tendency to resort to underhand means of obtaining traffic, and accordingly we have had constant rate cutting, and—what shall I call it?—all the deviliments of rebates and underbilling and cheating in different ways which unscrupulous agents could invent. Pooling was abolished by the Inter-State Commerce Act, and the system of differentials in rates was the only one left which could be substituted for it, so as to afford to each company the means of securing its proper agreed proportion. It was the only means, in fact, by which the traffic could be legally divided amongst the various routes in agreed proportions; but the system of differentials was unfortunately neutralized and set at nought by the action of the associated—or dissociated, I perhaps ought to say—companies, and no agreements were of any avail; and there has been of late a deficiency of good faith amongst the different controlling interests which render it difficult to obtain any satisfactory and combined result, or to avoid undue competition. I may mention, however, that during this period of rate cutting, we did not get a smaller proportion of the total traffic out of Chicago than we had before, but a larger proportion; which shows that our officers were doing all they fairly could for us under disadvantageous circumstances.

I am happy to say that we are coming in this current half year, and for the next twelve months, to an opposite set of conditions—(Cheers). The regions from which our through rail traffic is mainly derived, viz., Michigan for wheat, and the Western States for Indian corn, which is still more important—are blessed with plenty this year, against comparative failure last year. There has been as they told me, and as I saw with my own eyes, in the Southwest and the West the most abundant corn crop the world has ever seen.

ECONOMY IN THE OPERATING DEPARTMENT.

As regards the expenses which have been charged to revenue, you will observe that they have been reduced by $209,625, and I may mention that this reduction has been made in the face of higher prices for fuel and for wages, which have to some extent neutralized the efforts which our officers have made to keep the expenses at a lower figure. The cost per mile of working, maintaining and repairing the engines was 21.18 cts. in 1887, against 21.72 cts. in 1888. We have been doing a good deal in the way of consolidating our locomotive department. The locomotive shops at Stratford have been built, and are in use. They cost altogether $107,000. Mr. WALLIS, who has been our locomotive superintendent so long on the Grand Trunk, will in future take charge of the whole of the Grand Trunk system east of the St Clair river; and Mr. DOMVILLE, who was the locomotive superintendent at Hamilton, from whence we have removed the machinery of the locomotive works, will in future undertake a very important business for which he is particularly well qualified, and in which he has met with a great deal of success already—in making castings, and particularly car wheels, for the whole system. I had a talk with him on the subject, and he is very sanguine of being able, not only to supply us with more reliable wheels for all our freight cars, but also to save us no less than $30,000 a year in doing it. Mr. WALLIS has done so well in the past that I think it is right to say a few more words about this matter. I have not for some time told you what has been done in our locomotive department, and, therefore, I should like to say a few words showing what improvements have been made in it. You will remember that our change of gauge was made in 1874. Since October, 1874, there has been no appropriation whatever from capital for new locomotive engines for the Grand Trunk division. There have been built in the Montreal shops since January, 1880, 137 new locomotive engines, solely out of revenue, to take the places of others that have been sold and worn out, and these new engines are of a far better type and of greater power than those they have replaced, having improved boilers, and working up to a maximum pressure of 160 lbs. The increase in the gross weight of our trains is 25 per cent., and the increase in the net freight we carry is 38 per cent., whilst the decrease of gross cost per ton mile is 39 per cent., and the decrease is net cost per ton per mile is no less than 46 per cent., and the cost per passenger car per mile has been decreased by 17 per cent. It is only by this great measure of economy that we have been able, in carrying our traffic, to meet the very low rates which we have been able to obtain, and to do as well as we have done. And these results have been brought about, I may say, partly by the increased power of the engines and capacity of the cars, partly by the system of circular running which we have been able to adopt since we obtained possession of the Great Western system, and the fusion of the two companies together, and partly by the reduced price of fuel, which is not so high as it used to be, although it is rather higher than last year. It is interesting to compare the prices of materials, and fuel, and wages with those obtained in England. I find that the wages of mechanics in Canada are 33 per cent. higher, and the cost of the materials are from 24 to 72 per cent. higher. Looking at the matter as a whole, I find—allowing for these differences of conditions—that the results which we have obtained compare very favorably with English practice.

THE ATCHISON, TOPEKA & SANTA FE.

I am happy to bring you a very good report of the condition of the Chicago & Grand Trunk Railway, and of our position generally in Chicago, as well as of our connections there with other roads; and last, but not least, that with the Atchison, Topeka & Santa Fé Railway; and I may mention to you that of the many thousands of miles which I traveled over the United States roads, that when I came back to the Chicago & Grand Trunk I had found nothing that ran so smoothly and comfortably as I did over the Chicago & Grand Trunk, which is practically on a par with the remainder of the Grand Trunk system. Well, the Chicago & Grand Trunk is improving, and developing as regards its traffic. In spite of these bad harvests—in spite of the competition and low rates to which it has been subjected—in spite of higher wages, and in spite of the loss on low rates on the dressed beef, it has covered the half year's interest charges. Well, this is a part of the advantage which we have derived already from our arrangements with the Atchison, Topeka & Santa Fé Railway, from which we may hope for a great deal in future. The gentlemen connected with that line are, I understand, very much pleased with the assistance which we gave them for entering into Chicago, which is a very difficult matter for a new company, and a very expensive matter, and for the accommodation which we afforded them, and the officers of our company and their company are on the most friendly terms—(Cheers). I was very glad of the opportunity of running over their line and becoming acquainted with it; and I may mention to you, in regard to the eastern portion of it—which is that which more particularly interests us—through the States of Kansas, Missouri & Illinois, that it runs through splendid country—some of the finest in the United States; and Kansas City, a great manufacturing center, with its 250,000 inhabitants, is still growing rapidly. It is full of cable tramways, the cars of which travel constantly and with great velocity, and almost make you giddy at every corner of every street. The 458 miles from Kansas City to Chicago was only opened this summer, and some improvements are still in progress on that part of the line, but the traffic over it is now running regularly and freely, and the equipment of the line is of the most modern type, and of the best possible description. The train by which I traveled had vestibule Pullman cars, heated by steam, and lighted by the electric light throughout; and even all the freight cars are fitted with the Westinghouse

automatic brake; so that it is, in all respects, a first-class corporation with which we have thus got into connection, and with whom we hope to exchange more and more of traffic.

THE MONTREAL STATION.

You know that we are building a new station at Montreal. The old passenger station there was very insufficient and very unhealthy. It has now been entirely swept away. The yard has been raised, and a new station has been built, and it is giving satisfaction to everybody. I may say that, having regard to the nature of the times, we ventured to curtail the expenses to some extent. We did not think it was necessary to build towers to that station, or to go into any useless expenditure, but we built merely a plain station, which would be good and healthy, and sufficient for the traffic —(Hear, hear). Now that the station has been built, I believe it meets with very general approval, not only for its usefulness but also for its appearance; and I must say, when I went to see it and compare it with the more expensive station, which the Canadian Pacific are building not far from it, I thought that our station was by far the better looking of the two, and the more convenient for working.

DOUBLE TRACKING.

I ought to say a word or two to you about the doubling of the line. Nothing gave me greater satisfaction than to see it proceeding rapidly, and to run over portions of the double line already opened between Toronto and Montreal, because it is, I am convinced, in the interests of the company very much needed.

We hope to have it completed by the end of this year for the following distances:—From Montreal to St. Anne's 20½ miles, from Brownsville to Cornwall 40½ miles, from Brockville to Gananoque Junction 29¾ miles, from Belleville to Sydney 6½ miles, from Scarborough to Toronto 9 miles. These figures give a total of 106¼ miles, which is a satisfactory proportion of the distance between Montreal and Toronto, nearly a third of it; and, including the Great Western section and some other points, we have now got altogetether 193 miles of double line. We hope also to be able to make some little progress this autumn in grading a further portion, and by the end of next year to have no less than one half of the whole distance between Toronto and Montreal completed as a double line. Of course, in doubling the line we have also improved the gradients and curves where we could.

THE ST. CLAIR TUNNEL.

One of my first duties on reaching America was to visit Sarnia, and to discuss with Mr. Hickson and Mr. Hobson, the engineer of our Great Western division, the question of the construction of the tunnel which we are going to make under the St. Clair River, and which, as you know, will connect our Chicago and Grand Trunk line, on the American side of the river, with the Sarnia branch of our Great Western section, on the east side of that river. To make this connection, as you will remember, will require altogether three miles of line, of which one mile will be tunnel, and of which tunnel half a mile will be under the river. We commenced, as you will remember, by making arrangements with certain contractors to sink shafts on each side, and drive an experimental heading, to test the material through which we had to make the tunnel. By means of the heading we ascertained precisely the difficulties which have to be encountered, and we were then able to prepare the exact means and appliances that we required to surmount these difficulties. We found it was necessary to have shields working from both sides of the tunnel to meet in the middle, and we have since been preparing those shields. They are of elaborate construction, and are very much larger than any which have hitherto been used. The largest that have been used previously are from 10 ft. to 12 ft., whereas the shields that we shall use for our tunnel will be 20 ft. or more in diameter, and our tunnel will be four times as large in area as any tunnel previously constructed by such a process. We have now prepared the machinery—namely, the shields for excavating the tunnel, the means for lighting the works by electricity, and for ventilating and pumping, and all the apparatus ready for the work; and we have considered the question as to how the work should be carried out. The first idea was to begin the boring of the tunnel from a shaft at each end; but, after full deliberation and discussion, we determined that by far the better plan would be to put the shields down in the first instance, at the portals of the tunnel, as being the simplest mode, and as giving the engineers and workmen the best opportunity of getting thoroughly into practice with the shields before they came to what they considered, but which I do not think they will find, the most difficult work—viz., that under the river. While I was in Canada the land was purchased on either side of the river, and now Mr. Hobson is ready to commence his excavations on the approaches to the depth at which the shields will be fixed, and I hope at the next meeting to report that considerable progress has been made. I may also state that up to the present time in all these experiments and preparations, the cost has only been $100,000.

The remainder of President TYLER's address concerning the relations of the Grand Trunk to the Canadian Pacific, we postpone to our next issue.

Sluice Gates for Dams.

In our issue of Nov. 3, Mr. B. H. HULL answered a query of Mr. H. TILLY BROWNE as to the form of sluice-gates for masonry, timber, earthen or masonry dams for irrigation purposes among others. At our request Mr. HULL has sent plans of several of the gates described, which we now give.

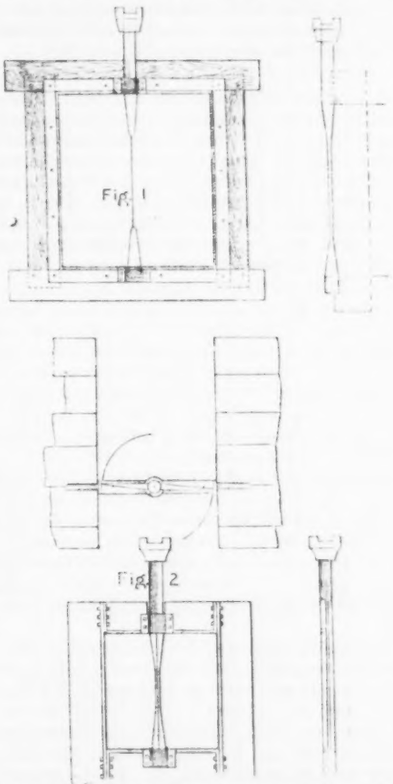


Fig. 1.—36 x 36-in. Sluice-Gate; for Timber Dam.
Fig. 2.—36 x 36-in. Sluice-Gate; for Masonry Dam.

The plans indicate the general arrangement only for 36×36 ins. and 20×20-in. gates. Figs, 2 and 3 have cast-iron frames fitted for building into masonry sluice-ways for various purposes; while Fig. 1 shows an angle-iron frame fitted to a timber sluice. As shown on the plans the lower part of the stem or gate-shaft is cast with the gate; and for ease in operation one blade of the gate is about 2 ins. larger than the other. It is understood, of course, that these gates must be proportioned in strength to their position and the head under which they operate and Mr. HULL says that in his practice the thickness of metal ranges from ¾ in. to 2 ins.

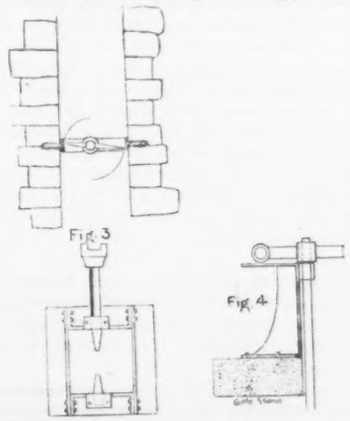


Fig. 3.—20 x 20-in. Sluice-Gate; for Masonry Dam.
Fig. 4.—Gate-Stand.

The worm-gear for operating the gates must also be designed for the work to be done in each case, and may range from 1¼ ft. to 3 ft. in diameter of large wheel. These gates can be fitted to a circular conduit by putting them in a chamber large enough to permit the gate to turn. They have been much preferred to the ordinary slide gate, as having much less frictional area than gates of the latter type. It should be mentioned that the blades and the frame are planed where they come in contact and the edge of the blade has a small bead on it, causing a tight fit. To prevent wedging, a small but strong stop-pin is fixed in the frame. The gates are not new in any of their parts; but practice and long experience have shown them to be simple, efficient, easily operated and relatively cheap.

An Automatic Rock Dumping Scow.

The scow here shown for automatically dumping rock or other material in dyke-construction was used at Newburyport, Mass., in harbor works. The contruction and operation is as follows:

The scow is about 65½ ft. long and 29 ft. wide; on this is placed a platform A, 32 ft. long and 22 ft wide, which is arranged to slide on 8 roller-ways inclined at an angle of 1 in 28, transverse to the axis of the boat. Between these ways, shown at w Fig. 2, are three struts or braces s, one in the middle and the others near the end of the platform. The lower ends of these braces turn on a vertical bolt d fixed to the deck of the boat and the upper ends abut against strong blocks fixed to the platform A. These three braces are tied together by a rod r attached to a lever l, which by a simple movement releases the braces from their blocks and leaves the platform A resting free on the rollers. Wooden guides, x and y, keep the platform to its track.

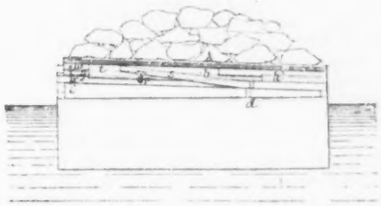


Fig. 1. — Elevation.

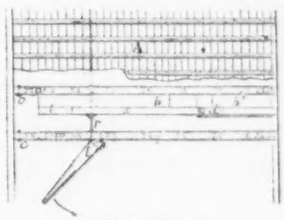


Fig. 2. — Plan.

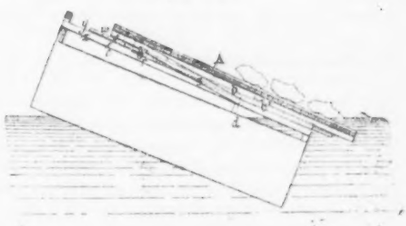


Fig. 3.—Unloading.
An Automatic Dump-Scow.

The dumping operation is as follows: As soon as the braces are released the platform glides outward by reason of its load and the inclined track. After moving about 3¼ ft. it is checked by bringing in contact the blocks b and b^1 fastened one to the platform and the other to the deck of the boat. Under the change in the center of gravity the boat assumes the position shown in Fig. 3 until the deck-load is discharged, an operation consuming about 10 seconds. As soon as the empty boat rights itself again the workmen run the platform back into position and secure it there by the braces s.

THE NICARAGUA CANAL charter was granted by the Vermont Legislature on Nov. 13. The act of incorporation is practically the same as that passed by the U. S. Senate last session.

ENGINEERING NEWS

AND AMERICAN RAILWAY JOURNAL

Published Weekly at Tribune Building, New York.

VOL. XX. Saturday, November 24, 1888.

D. MCN. STAUFFER, A. M. WELLINGTON. EDITORS.

GEO. H. FROST. - - - - - BUSINESS MANAGER.

Subscription. — UNITED STATES AND CANADA, $5.00 *per Year;* $2.50 *for Six Months;* $1.50 *for Three Months; Single Copies,* 12 *cents.* FOREIGN COUNTRIES, $6.56 *per Year, or* 3 *cents per number additional.*

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Coming Technical Meetings.

Engineers' Club, Philadelphia, Pa.—Regular meeting, Dec. 1. Secy., Howard Murphy, 1122 Girard St.

Civil Engineers' Society of St. Paul, Minn.—Regular meeting, Dec. 3 Secy., Geo. L. Wilson, City Hall.

Engineers' Club of Kansas City, Mo.—Regular meeting, Dec. 3 "The Steam Engine; its Beginning, Growth and Place in the Industries of To-Day", C. A. Burton. Annual meeting, Dec. 5. Secy., Kenneth Allen, Y.M.C.A. Building.

Western Society of Engineers, Chicago, Ill.—Regular meeting, Dec. 5. Secy., L. E. Cooley, 171 La Salle St.

Engineers' Club of St. Louis, Mo.—Annual meeting, Dec. 5. Reports of officers and Committees. "Condensers for Steam Engines", Prof. J. H. Kinealy. Secy., Wm. H. Bryan, 709 Market St.

American Society of Civil Engineers, New York.—Regular meeting, Dec. 5. Secy., John Bogart, 127 E. 23d St.

Civil Engineers' Club of Cleveland, O.—Regular meeting, Dec. 11. Report on Railroad Engineering. Secy., James Ritchie Case Library Rooms.

New England Railroad Club.—Next meeting at Boston & Albany R. R. passenger station, Boston, Mass. Dec. 12.

WE have received a number of communications in regard to the computation of earthwork, in part suggested by Prof. ECHOLS' letters of Nov. 3 and Sept. 22, and in part not, all of which we are obliged to decline. In so far as they relate to various ingenious methods for dispensing with plotting irregular sections they are delusions and snares, and as to the rest, all we can say is that "what is new is not good, and what is good is not new". We wish to indorse what one correspondent says as to cross-sectioning, however, that it should always be done with the double marked metallic tapes; all the work being done with the red side marked with cuts or fills only, and the actual distances out not read until after the slope-stake has been set. This device is no longer new, but it is in anything but universal use, although it greatly increases the rapidity and accuracy of cross sectioning. The distances out should always be recorded, however, as a check upon the notes. The conclusion of the whole matter is that the proper way to compute earthwork is to plot all irregular sections and compute their area by the planimeter, or from diagrams; read off all other areas and volumes from diagrams without any computation except addition of the end readings; compute the volume by the "end area" method only for use in monthly estimates, and at any time before the final estimate determine a "prismoidal correction" for those solids only which differ 3 ft. or more in center height, to be subtracted in gross from the end area volumes; the section being regarded for the purpose of obtaining this correction only as level sections of their actual center height, and *not* reduced to "equivalent level section," which is worse than labor thrown away.

This method is at once simpler and quicker than the simplest other method, and more accurate than the most accurate which can be devised and applied with any amount of labor. There does not seem room, therefore, for much more profitable discussion of the subject.

A CORRESPONDENT asks us to "kindly refer him to the most exhaustive treatise on rail-joints in general", but we regret that we are unable to do so, other than by a general reference to the files of our own and other engineering journals of the past few years, in which he will find much relating to the subject, and from a general average of which alone can he become familiar with the latest state of the art in that respect. Not even any single article, or series of articles, can be regarded as "exhaustive" of the subject, which after all is a pretty broad one; and there are few or no engineers, whose views would be deemed worthy of attention, who feel that they are fitted to write such an article, for there are few who have not many and grave doubts yet as to precisely what is the "perfect joint", or as nearly perfect as it will be possible to attain. The only perfect joint will be no joint at all, which will be secured when some genius perfects a way for welding rails together *in situ*. There have been hopes and claims that this end was already secured by electric welding, but the evidence of this fact is as yet lacking.

One thing only may be considered as positively established, that the short fish-plate or angle-bar in any form is very far from a perfect joint, and is likely to vanish fast into innocuous desuetude. Of the joints which still promise well and have firm friends there are only two of prominence, the long three-tie angle-bar and the Fisher bridge joint. These joints are in a certain sense diametrically opposed to each other in principle, yet we are not aware that either has as yet failed to make an excellent record for itself wherever it has been tried on an extensive scale. Which is now advancing fastest in popular favor we are not in a position to say, but the long angle-bar joint is being more and more used every day, and a great many think it is the final solution of the problem. One cannot but remember that the same was true of the fish-plate and angle-bar joints when they were first introduced, and jumped almost immediately into popular use. Whether history is to repeat itself we cannot say, but so far the three-tie joint is doing well.

IN looking over the annual report of the directors of the Old Colony Railroad Company, we came upon the following paragraph which we quote, italicizing the sentence to which we wish to call attention:

"Before the union with the Boston & Providence Railroad, urgent applications were made to the directors to build a railroad from Walpole, through Wrentham, to North Attleborough. *These applications were refused, from an unwillingness to encroach upon the territory already occupied, in part, by another corporation.* Now it seems to the directors necessary to make this connection and perhaps, extend it to a junction with the West Roxbury Branch at Dedham, and they therefore ask the stockholders for authority to construct this railroad.

One would probably have to search through a very large pile of reports of railways in the West and South, before he would find a parallel statement to this. It would probably strike a very great number of our railway managers as a very strange idea that a valid reason for *not* building an extension was that it would encroach upon the territory already occupied in part by another corporation. On the contrary they have been regularly pursuing the policy of building extensions for the purpose of encroaching upon each other's territory.

Again, as we glance down the current list of stock quotations, we note Old Colony quoted at 175; and we may look at every other railway stock on the list, from the rattle-traps which never paid a dividend and never will, to New York Central at 109, or even the "coalers", and not a stock, good or bad, comes anywhere near equalling the price of the Old Colony with the sole exception of the New York, New Haven & Hartford at 235. Now is there any connection between the quotation above from the directors' report and the stock quotation? Of course there are a great number of other "circumstances which alter cases". But isn't it just possible that this leaf from the policy of the directors who manage the railway which has for its common stock the second highest quotation of all the railway stocks of the United States, may be worth a little candid consideration on the part of the managers of railways whose stock does *not* sell at 175?

AT last the Pennsylvania Railroad Co. has been graciously permitted by the Jersey City authorities to spend its own money in providing for the greater safety of the public, and the work of elevating the tracks at a cost of $1,000,000 has been begun. That which Buffalo and other cities are glad to pay a considerable sum for was offered to this enlightened burgh for nothing; but although 300 of its inhabitants per year are being killed and injured at the numerous grade crossings within a distance of less than a mile, private greed, with no foundation of justice under it, has been permitted to stand in the way of curing this condition of things for over a year. It is estimated that the saving in expenses alone will more than pay interest on the expenditure. The following we have ascertained to be the actual figures of the cost per month of protecting grade crossings in Jersey City.

Crossing	Force	Day	Night	Total
Greene St	Flagmen	6	5	11
Washington St	"	3	3	6
Warren St	"	2	2	4
Henderson St	Gatemen	1	1	2
Newark Av	"	2	2	4
Grove St	"	1	1	2
Barrow St	"	1	1	2
Jersey Av	"	1	1	2
Cole St	"	1	1	2
Extra Gatemen and Flagmen				3
Total men				38

38 Flagmen and Gatemen at $40	$1,520.00
Labor for repairing gates (approximate)	17.70
Material " "	24.60
Maintaining crossings	
Planking	502.00
Labor	250.00
Total monthly expenses	$2,314.30
Or per year	$27,771.60

On the other hand the interest on $1,000,000 is only $40,000 a year, and from this must first be deducted a saving due to the cheaper maintenance of the elevated tracks, apart from the crossings and gates, which will be at least $5,000 per year. Making the most moderate estimate of the legal, surgical and other incidental expenses, it will be seen that the Pennsylvania stands in to save some thousands of dollars a year in cash, as well as what no one seems to count or care for, the 300 or so deaths and injuries which are otherwise as certain to come as each succeeding year.

Too much credit should not be given to the Pennsylvania for its action in the matter, beyond that of being able to comprehend and live up to an enlightened self interest; which alone is no small credit, for it is none too common. The company do not pretend to have been actuated only or chiefly by humanitarian considerations, for they admit expressly

that besides heavy legal expenses and judgment damages for these 300 deaths or injuries per year, which alone mount up to a very large sum, and ought to, "the wages of the flagmen and other expenses dispensed with as no longer needed, will more than pay the interest on the cost of the new work"! and in this enlightened country we have to wait till this condition comes about before such improvements will be begun or demanded!

COULD anything shed a more pitiful light on the actual conditi on of our civilization in this respect than that such a fearful aggregate of suffering must count for nothing, as it practically has, in determining whether a remedy shall be sought, or even permitted to be applied? Supposing that there were no cash saving at all, but only the saving of life and limb: Have we come as a people to that point of greed for gain that we consider $2,000 a high price to pay to save a life, or saving $1,000 as an adequate balance against making a cripple for life? It is to be remembered that these sufferers are often if not usually, industrious, hard-working, capable men, and that in any case the suffering caused is not confined to the individual but affects profoundly on an average two or three persons for life, often ruining the future of a whole family. As a mere question of money, can we afford to make cripples when $40 a year will save them, or lose lives to save $80 a year, even if the cost of saving them were all pure outlay? Nothing can bring out better the inhumanity of the conditions which exist more or less in every city and town of the country than such questions as this, and the country needs to be more thoroughly awakened to the barbaric folly of permitting them to continue. We are not altogether to blame for it, as we have often said. It is an inheritance from the days of small things. When these practices were first established both the people and the railways were few and poor. There was no powerful landed interest and vast accumulated wealth to enforce and permit a higher standard in the beginning, and perhaps on the whole it was fortunate that there was not. Again, we had and still have a vast railway system to create, which was of even more importance for the good of all, than saving a few lives. Every man could better afford to take his chance of being himself a sufferer than to have the development of the country impeded as it would have had to be by too heavy expenditures in early days. Thus, both the people and the railways were educated, not without excuse, to a low and rude standard of operating safety in this detail. But we are no longer few nor poor. The north-eastern quarter of our country is already filled by the richest people on the globe, and they need to be awakened to the fact that they are living still in barbarism in this respect, and that killing people by wholesale to save a few thousand dollars each, as is now done to some extent in every city on this continent, is "worse than a crime, a blunder," and an inhuman as well as foolish kind of blunder.

MR. J. IMBRIE MILLER, who resigned his position this week as Principal Assistant Engineer of the New Croton Aqueduct, has been especially active in the detection of the bad work on the upper divisions of the aqueduct, previously commented upon by us, and in superintending the repairs. His services in this direction have called out a well deserved resolution from the Commission commending him for his faithfulness and engineering skill: Mr. MILLER has been one of the most faithful and competent engineers in the service of the Commission.

The C. B. & Q. Train Resistance Tests.

The tests of which we gave a full abstract last week, are perhaps as good evidence as yet exists in print in any single tests as to the actual train resistance at high speeds, the proportion of engine resistance therein, and the effect of wind on train resistance. They are not in all respects as complete as might be desired, nor probably as complete as they will be in time, and certainly cannot be accepted as in themselves conclusive where further corroborative evidence does not exist; but to a large extent they are so corroborated, and the main results are very significant and interesting as they stand, especially as respects the effect of wind and the proportion of engine and car resistance.

The indications as to the effect of the direction and force of wind on the train resistance of the train proper, behind the tender, were shown graphically in Figs. 1 to 6, p. 385, of our last week's issue, showing the computed train resistance and speed on a 5-mile run (mile-posts 76 to 41) each being determined at about 27 different points on that run. They were also shown numerically in Table 6 for 6 to 7 different mile-posts between M.P. 43 and 75, where the line was a level tangent and the speed uniform.

These somewhat surprising results may be summarized thus, taking the average of all the observations:

Table A. *Apparent Effect of Wind on Train Resistance.*

	Wt. train tons	Speed m. p.h.	lbs. per ton
Clear day, no wind (Table 6)	327	50	12.2
" " "	344	43	9.5
Strong opposing wind (Table 6)	267	40	10.1
" " "	289	44	7.75
" " (Fig. 3)	—	37	15.
Strong favoring wind (Table 6)	317	41	8.5
" " "	412	44	9.0
" " (Fig. 5)	—	45	12.5
Light favoring wind (Fig. 1)	—	44½	11.
Light opposing wind (Fig. 2)	—	33⅓	13.
Average of all observations	.....	42.2	10.86
" no wind	.....	46.5	10.85
" strong opposing wind	.....	40.3	10.95
" " favoring wind	.....	43.3	10.0

The only legitimate conclusion from the face of these figures, is that a wind blowing either with or against the train, if its direction is with the train, has little effect on train resistance. There is indeed some trace of adverse effect from wind, the strong opposing winds creating 1 lb. per ton more resistance than exists with the favoring wind at 3 miles per hour less speed, but it is very slight. To indicate whether this is a truthful result, or due to some accidental cause or source of error we have the following very significant contrast as to the effect of side winds; Table B.

TABLE B. *Apparent Effect of Side Winds.*

	wt. tr'n tons	Speed m. p.h.	lbs. per ton
Strong side wind (Table 6)	275	43	18.5
" " "	329	39½	12.7
" " (Fig. 4)	—	44	17.
Average strong side winds	....	42.3	16.1
" no wind	....	46.5	10.85
" strong opposing wind	....	40.3	10.95
" " favoring "	...	43.3	10.0

distinction between the observations given in the contrasted tables. The resistance from side winds shows a distinct tendency to increase with speed, not only in the averages which we give in the above tables, but in the individual observations from which the averages are taken, as given last week; whereas the reverse is the case, on the whole, with the opposing and (especially) favoring winds, as is especially noticeable in Fig. 5, given last week. At least the indication is tolerably distinct, so far as it goes, that there is little if any increase of train resistance behind the tender from opposing winds for moderate variations of the usual passenger speeds.

As a check upon these figures, we have the records of the average resistance during 16 entire runs of 125 miles each, from Aurora to Galesburg, given in Table 2 last week. It is to be remembered that many causes for variation exist, besides errors of observation due to the imperfections of the dynamometer or possible errors of computation; such as number of stops, which varied from 7 to 11, temperature, differences in engines (4 different ones being included) etc., etc., so that any close exactitude is not to be expected; but averages tend to eliminate all these accidental sources of error, and bring out the permanent causes for variation if such exist.

Classifying the runs according to the state of the wind, we have the following very curious comparison; Table C.

It is impossible to accept this table at its face value, which is, that there is rather more resistance when there is no wind at all than under any other conditions, and the fact of such an appearance admonishes us that dynamometer records are not minutely reliable, a fact which we have often before pointed out. A fact which almost proves that there is some error of observation contributing to cause the anomaly referred to, is that the computed efficiency of the coal is approximately in some inverse ratio to the train resistance. In case of conflict, we should consider the coal record entitled to at least equal weight, and at the end of Table C we give a column which shows *relatively* what the coal record indicates, which is, a difference of 4 or 5 per cent. only in the comparative resistances.

But all the more because of this apparent conflict of evidence, the facts which still appear

TABLE C.—*Averages of Entire Runs of 125 Miles.*

Kind of Wind	No. of runs.	Average speed m. p.h.	Average r'sist. lbs. per ton		Coal per H. P. hour of work on train behind engine	*
Strong side wind	1	37.3	13.3		9.0	120
Light " "	1	34.6	15.1		7.0	105
Strong head "	2	36.7	10.6	(9.7, 11.5)	10.95	116
Light " "	2	32.8	12.7	(12.4, 13.0)	9.35	119
No wind	4	37.8	15.05	(11.4 to 18.4)	8.52	128
Light rear wind	2	38.1	11.25	(10.3 to 12.2)	10.9	122
Strong rear wind	4	38.8	10.6	(8.4 to 12.8)	11.18	118
General average	16	37.07	12.51		9.82	123
Average side winds	2	36.0	14.2		8.0	114
Average head or rear winds	14	37.2	12.27		10.00	124

*Product of last two columns, showing the *comparative* car resistance for equal efficiencies of coal.

Here at least there is no difficulty in determining an effect from wind; it is very clear and distinct in the case of side winds, showing an increase of 5 to 6 lbs. per ton, or over 50 per cent. Moreover, there is another very curious clear through it all are all the better established; and the general fact appears clear that the resistance of the cars behind the engine is very slightly affected by the wind, whether it be a head wind or following or no wind at

all; and that a side wind does more harm than any other. In this perhaps we have the explanation why so much indifference is shown to alleviating wind resistance by giving a "peaked" form to the front of the locomotive.

At high speeds of 35 to 40 miles per hour, if we might trust implicitly the preceding indications as to the car resistance only, we should be led to the conclusion that it remains nearly constant at all passenger speeds as well as in all winds except a side wind, at say 12 lbs. per ton; and in that case we should have all the velocity resistance represented by the increment in engine resistance only. It is, however, quite certain that this is not strictly the case, since it is well determined that the resistance of such passenger trains as we are considering is not, at under 20 miles per hour over 6 to 7 lbs. per ton, engine included. The train resistance tests made during the Burlington brake tests on this same road proved that, and the increase to 10 to 14 lbs. per ton at 40 miles per hour is quite certainly a velocity resistance which, if we could get at the facts accurately, would be found to increase either as v or v^2, all indications that the car friction under normal conditions can decrease as the velocity increases, being to that extent deceptive. It may well be, however, that there are causes tending in that direction, and various careful French experiments have indicated that the car resistance increases as v and not v^2, which seems to be precisely the indication of these records.

It may be even that the increment is less rapid than v; but how is it with *total* resistance of the train, including engine and head resistance? This after all is the significant factor; for it matters little where the resistance is, so long as it exists. The train resistance proper appearing to increase but slightly with speed, if the engine resistance likewise increased slightly with speed, the per cent. of the indicated power transmitted back of the tender would remain constant at all speeds; but if the engine resistance increased rapidly with the speed, we should expect to see a constantly decreasing proportion transmitted back from the engine. Such was very distinctly shown to be the case in diagrams *A*, *B* and *C* showing the per cent. of indicated power transmitted to the train, the fluctuations (shown in detail on the diagrams) being very moderate, and the law that the engine resistance increases about about as the square of the velocity very distinctly indicated, as shown in the following tabular abstract from these diagrams, based on the average line of each diagram only:

TABLE D.—*Ratio of Engine Resistance to Total Resistance.*

Spe'd m. p. h.	Av. p. c. of engine and tender resistance in total w'rk of eng.				Comput'd.*	Deviation from comp'd
	Eng. 157	Eng. 135	Eng. 352	Av.		+	−
10	16.0	14.7	—	15.3	19.	....	3.7
15	18.0	17.0	26.0	20.3	20.25	0.05	....
20	20.0	20.0	28.0	22.7	22.	0.7	....
25	25.2	22.6	30.0	25.9	24.25	1.65	....
30	29.0	24.5	32.0	28.5	27.	1.5	....
35	30.2	26.3	36.0	30.8	30.25	0.55	....
40	32.0	28.0	41.0	33.7	34.	....	0.3
45	35.0	29.3	48.0	37.4	38.25	....	0.85
50	42.5	30.0	57.0	43.2	43.	0.2	....
55	49.5	32.0	(60.0)	47.2	48.25	....	1.05
60	(58.0)	49.0	(65.0)	(57.3)	54.	3.3	....

Class of Engine.	Mogul.	6 driv'r	4 driv'r	Av.
Wt. train	473	389	343	402
" cars	390	310	275	325
" eng.	83	79	68	77
% wt. eng	17.5	20.3	19.8	19.1

* The column headed "computed" was computed by the formula which appeared best to average the actual results in simple form; viz, $R = 18 + .01\ v^2$, in which R = the ratio of engine resistance to total indicated work, and v = velocity in miles per hour. The purpose is merely to indicate how nearly the recorded results approach to varying as v^2.

If we let R = the ratio of engine resistance only, to total indicated work, and assume, as is indicated by the diagrams, that the equation of R has the general form:

$$R = f v^2 + c$$

we obtain by substitution from the values of R given for various speeds in Table D. above:

$$R = .0\,1\ v^2 + 18$$

as the one of simple form which best averages the recorded observations. How nearly it averages them is shown in the last columns of the table, where it will be seen that the differences are comparatively inconsiderable, the computed and observed values of R being for practical purposes identical. A higher constant than 18 and less coefficient of v^2 would approximate more closely, but be less simple.

Now it may be merely a coincidence, but it will be seen that at low speeds this value of R is almost identical with the ratio of the weight of engine to the weight of train, the average weight of engine for all these tests having been 19.1 per cent of the total weight of train, and the ratio of the engine resistance to the total at a velocity of 0 + being found to be 18 or 19. Up to 20 miles per hour the engine only shows 22 per cent. of the total resistance, which is but little more than that due to its weight. This may seem a surprising and inadmissible result, it being quite common to assign a much higher rolling friction to the engine than the train; but it is not in fact surprising, the evidence being now abundant that at low speeds the engine and train may be included together under a constant allowance for rolling friction in lbs. per ton, it appearing as if the internal machinery friction was really much less than is often allowed, or but little more than 5 to 7 per cent., and balanced in good part by lower journal friction, due to the better condition of the journals and greater weight on them.

From the figures just given we can easily deduce what the indications are as to the total train resistance, engine and cars both included. The *proportion* of the engine and car resistance is given by Table D. above and reproduced in the second and third columns of Table E., the respective weights of each being reproduced at the head of the columns. Given then the absolute resistance of the cars in lbs. per ton at each velocity (given in the fourth column), we obtain the total car resistance, as in the fifth column, and dividing this by the per cent. which the car resistance is of the total at each speed, we obtain the total train resistance in lbs., engine and all included. Dividing this in turn by the total weight of the train we obtain the average resistance of the entire train in lbs. per ton.

Assuming the car resistance to be 6 lbs. per ton at 10 miles per hour and 12 lbs. per ton at 40 miles per hour, as seems to be indicated, we have for the car resistance in lbs. per ton:

$$R = 4 + \frac{v}{5}$$

The French formula of M. RICOUR* for resistance in kilos. per tonne for velocities in kilos. per hour is

$$R = 2 + \frac{v}{40}$$

For resistances in lbs. per ton and velocities in miles we obtain, calling 1 kilo. per toune = 2 lbs. per ton (of 2,000 lbs.), as it as almost exactly, and 1 kilometer = $\frac{5}{8}$ mile, as it does very nearly:

$$R = 4 + \frac{\frac{5}{8}\,v}{20} = 4 + \frac{v}{32}$$

*Econ. Th. Loc. Rys. p. 527.

The last formula gives at 40 miles per hour a car resistance of 5.25 lbs. per ton, which seems quite inadmissible. We are strongly disposed to believe, the first given formula is very near the truth, since it conforms not only to the C. B. & Q. tests, but to some made on the New York Central by Mr. P. H. DUDLEY. Accepting it, we have the following table of total resistance:

TABLE E.—*Total Resistance of Passenger Trains, as indicated by the C. B. & Q. Tests.*

Vel. Miles per hour.	Ratio of eng. and car resistance to to'l, as ab've		Car resistance		Total train resistance.		Eng. resistance only.	
	Eng. 77 tons.	Cars 325 tons.	lbs. per ton	T'tal lbs.	T'tal lbs.	lbs. per ton.	T'tal lbs.	lbs. per ton
10	19.	81.	6	1,950	2,410	6.00	460	6.0
20	22.	78.	8	2,600	3,330	8.28	730	9.5
30	27.	73.	10	3,250	4,450	11.05	1,200	15.6
40	34.	66.	12	3,900	5,900	14.66	2,000	26.0
50	43.	57.	14	4,550	7,980	19.80	3,430	44.5
60	54.	46.	16	5,200	11,320	28.10	6,120	79.4

It is apparent from the method of obtaining the above table that the total resistance per ton of entire train cannot vary directly as v^2, since one factor in it varies only as v; but ascertaining what equation of the general form

$$R = f v^2 + c$$

will best fit the column of total resistances in lbs. per ton we find it to be.

$$R = .006\ v^2 + 5.5$$

This formula comes singularly close to D. K. CLARK'S "old original", for so many years accepted as authority, which for tons of 2240 lbs. was:

$$R = \frac{v^2}{171} + 8$$

or reduced to an equivalent for tons of 2000 lbs.:

$$R = \frac{v^2}{181.52} + 7.14 = .00552\ v^2 + 7.14$$

The computed results above, and those given by these two formulæ, compare as follows:

Speed m. p. h.	Compu'd lbs. p. ton as above	By formula, $R = .006\ v^2 + 5.5$		By formula, $R = .00552\ v^2 + 7.14$	
		lbs. p. ton	Error.	lbs. p. ton	Error.
10	6.00	6.1	+0.1	7.69	+1.69
20	8.28	7.9	−0.38	9.35	+1.07
30	11.05	10.9	−0.15	12.11	+1.06
40	14.66	15.1	+0.44	15.97	+1.31
50	19.80	20.5	+0.7	20.94	+1.14
60	28.10	27.1	−1.0	27.01	−1.09

This is certainly as close agreement as is to be expected, and indicates that D. K. CLARK'S formula was wonderfully exact as to aggregate resistance. The separation of the engine and car resistance also seems by many concurring indications to be a tolerably exact one and it is highly significant. It represents an enormous horse-power being expended by the engine simply in moving itself, as shown in the following table:

Speed m. p. h.	Horse-power expended by engine in moving itself = [total engine resistance × speed in miles p. hour × 88 (giving ft. per min.)] ÷ 33,000	*
10	460 × 880 ÷ 33,000 = 12.3	2.21
20	730 × 1760 " " 38.9	17.71
30	1200 × 2640 " " 96.	59.77
40	2000 × 3520 " " 213.	141.67
50	3430 × 4400 " " 457.	276.70
60	6120 × 5280 " " 975.	478.20

* This last column gives the result of a similar computation given on p. 522 of the "Economic Theory of the Location of Railways."

It will be seen from the comparison in the last column that these results are somewhat higher for engine resistance than has previously seemed probable, or we may add, than seems now probable. An average of the two might come nearer to the truth. But from any

point of view the figures indicate that an enormous proportion of the work of a passenger engine is expended in simply moving itself. The query naturally arises: Can this be in any way reduced by modifying the form of the locomotive to reduce head resistance? We believe that it might; but there remains the question: Will not the car resistance behind the tender increase *pro rata*?

It is also to be remembered that the two classes of engines which we have averaged (American and Mogul) showed a decided percentage of difference in favor of the Moguls. This and some other points of the tests we had intended to comment on, but space forbids.

The Railway Systems East of Chicago.

II.

THE MINOR CANADIAN SYSTEMS.

The Government of the Dominion of Canada and the local Governments, Provincial and Municipal, have taken an important part in the development of the railways of Canada. The Grand Trunk company in its early years was backed by a Dominion loan of 15 million dollars, and the lines added to the original have been aided by heavy bonuses. The help which the Dominion Government has rendered to the Canadian Pacific was fully described in a recent issue (ENG. NEWS, Sept. 29). Independent lines in various parts of the Dominion have been and are being fostered by subsidies, sufficient in some cases to pay with the local aid secured the entire cost of building the road. In round numbers the total cash bonus received by Canadian railways now amounts to about 120 million dollars; and besides this, land grants of great extent have been and are being made to foster the work of railway extension.

But in addition to this stimulus of private enterprise, the Dominion Government directly owns and operates in Quebec and the eastern Provinces railway lines with a total extent of 1,236 miles. The Intercolonial Railway extends from Point Levi (opposite Quebec) to Halifax, Nova Scotia, a distance of 678 miles, and an 80 mile line to St. John, with other shorter branches, makes the total extent of the system 917 miles. The railways on Prince Edward Island, 211 miles in extent, are also owned by the Dominion Government.

The only remaining system of size in Canada is that owned by the New Brunswick Railway company, 445 miles in extent, located in the Province of that name, reaching from the port of St. John north to Edmundston, and connecting on the west with the Maine Central and with the Intercolonial on the east.

Adding to the latest obtainable statistics the new construction during the past 18 months, and we may estimate pretty closely the present extent of railways within the limits of the Dominion at 13,000 miles. The ownership of these lines is divided as follows:

	miles.
Canadian Pacific	4,842
Grand Trunk	3,093
New Brunswick	445
Government Railways	1,236
Independent lines	3,384
Total mileage	13,000

Thus the independent lines form but 26 per cent. of the total mileage; and of the remaining 74 per cent., 61 per cent. is controlled by the two great companies.

THE NORTHERN NEW ENGLAND SYSTEMS.

The Maine Central system extends from a western terminus at Fabyan's, N. H., near the base of Mt. Washington, and a southern terminus at Portland, Me., east to the New Brunswick boundary. The total length of line owned is 303 miles and 325 miles are leased, making the total mileage of the system 628 miles. The company pays regular dividends of 6 per cent. and its traffic is growing steadily with the increase in population and industries of the country tributary to it. For while the other New England States are no more than holding their own against the diversion of manufactures to the West and South, the State of Maine is enjoying a steady and healthy growth, and is making the most of her natural resources. A striking evidence of this growth was given in our editorial on the Water-Works of New England, (ENG. NEWS Oct. 13, '88) where it was shown that half of the water-works in Maine had been built during the past two years.

The Boston & Maine system, which was outlined in color on our map in the issue of Nov. 10, extends from Boston and Portland to western termini at Northampton and Worcester, Mass., and Keene and Claremont, N. H., and northern termini at No. Conway, N. H., Sherbrooke, P. Q. and Maquam Bay, Vt. The system was brought into prominence a year ago by its absorption of the Boston & Lowell system and the legal difficulties attendant upon the deal. The Boston & Maine system has now a total extent of 1,346 miles, of which 737 miles were acquired by the lease of the Boston & Lowell system. The company has a heavy local and suburban traffic on its lines in eastern Massachusetts and its New Hampshire system carries a large summer travel. By its connection with the new line of the Canadian Pacific at Sherbrooke, P. Q., it furnishes a route for through traffic from the West to Boston. The Central Massachusetts railroad, terminating at Northampton, is expected to carry a large coal traffic as soon as the new route from Pennsylvania *via* the Poughkeepsie bridge is ready for business.

The Central Vermont system, also shown on our map, consists of a main line extending from a connection with the Grand Trunk Railway at St. John's, P. Q., 36 miles south of Montreal, south to a terminus on Long Island Sound at New London, Ct.; the Ogdensburg & Lake Champlain railroad extending from Rouse's Point, N. Y., west to Ogdensburg; and a few unimportant branches. The lease of the Rutland Railroad, from Bellows Falls to Burlington, Vt., 120 miles, expires in two years, and the line will then become part of the system controlled by the Delaware & Hudson Canal Company. The total extent of the system as it now stands is 734 miles. Its local traffic is light, and the line is chiefly important by virtue of its connection with the Grand Trunk system, to which it furnishes an outlet to New York and Boston.

THE SOUTHERN NEW ENGLAND SYSTEMS.

The Fitchburg system extends from Boston to Troy, N. Y., *via* the Hoosac tunnel, a distance of 191 miles; this with branches and leased lines makes up a total extent of 345 miles, of which about half is double track. It is the outlet to Boston for the Central Vermont; and by its connection with the Vanderbilt system and the Erie canal on the west, it forms a route to Boston for the trunk line traffic.

The Boston traffic from the Vanderbilt lines, however, is principally sent over the Boston & Albany. This system consists of a main double track line from Boston to Albany, 202 miles in length, and branches, making its extent 389 miles. The local traffic of the system is very heavy, especially on the eastern divisions; and it forms in connection with the New York, New Haven & Hartford Railroad the main line between Boston and New York City. The company pays regular 8 per cent. dividends and has an enviable reputation for the maintenance of high standards in every department.

The main line of the New York & New England system extends from Boston west 228 miles to a terminus at Fishkill on the Hudson, where a ferry connection is made with the Newburg branch of the Erie. Branches to Springfield, Worcester, Norwich, Providence, New Haven, etc., bring up the total extent of the system to 497 miles; nearly one-fourth of which is double track. The system has a very good local traffic on its eastern divisions, but it suffers on through traffic for want of direct connection with New York City or any other great center. The scheme for a new Hudson river bridge at Peekskill promises to benefit the through line by furnishing it closer connections with the coal roads west of the Hudson.

The New York, New Haven & Hartford system consists of a double track main line from New York to Springfield, Mass., with branches to New London, Willimantic, Waterbury and Winsted, Ct.; and to Holyoke, Northampton and Shelburne Falls, Mass., a total of 517 miles. The main line division from New York to New Haven, which is eventually to be made a four track road, is one of the most profitable pieces of railway property in the country, as it is practically the sole rail outlet from New York City to Boston and New England points. The company has paid 10 per cent. dividends for many years, and its stock has not been quoted below 200 since 1885.

The Old Colony system, which was outlined in color on our map, probably covers a smaller territory in proportion to its size than any other system in the United States. With the exception of the line extending north to Fitchburg and Lowell, and a few miles in the State of Rhode Island, the system lies wholly in the southeastern corner of Massachusetts; yet it is 527 miles in extent, and about 100 miles are double tracked. Its traffic is wholly local, except that by connection with the line of Sound steamers from Fall River and Newport to New York a large passenger traffic is secured between New York and Boston.

The total mileage of New England as given in the last issue of *Poor's Manual* was 6,458 miles. The eight systems enumerated above have the following mileage:

System.	Total Mileage.	Total within New England.
Me. Cen.	628	628
Boston & Me.	1,346	1,300
Cen. Vt.	734	547
Fitchburg.	345	236
Boston & Albany	389	349
N. Y. & N. E.	497	462
N. Y. N. H. & H.	517	490
Old Colony.	527	527
Total	4,983	4,548

Adding to this last total the mileage within the limits of New England controlled by the Canadian Pacific and Grand Trunk companies, 204 miles, and we have for the total mileage in New England included in the large systems, 4,752 miles, leaving the mileage of the short independent lines, 1,706 miles. By percentages of the total the proportion is: mileage in systems 73½ per cent., mileage in independent lines, 26½ per cent. By a curious coincidence this is almost exactly the same proportion which we found above for the Canadian systems.

PERSONAL.

CHAS. F. LOWETH, M. Am. Soc. C. E., Consulting Civil Engineer, St. Paul, Minn., will carry on the business of the former firm of Loweth and Curtis, the partnership having been dissolved.

EDWARD COOKINGHAM has been appointed Assistant to General Manager W. H. HOLCOMB, of the Oregon Railway & Navigation Co. His office will be at Portland, Ore.

JOHN GRANT, a railway contractor, died recently at West Chester, Pa.

MR. HENRY C. ADAMS has been appointed Statistician of the Interstate Commerce Commission, with a view to the compilation of more accurate and complete statistics than heretofore.

C. F. RESSEGUIE has been appointed Superintendent of the Nebraska division of the Union Pacific, with headquarters at Omaha, Neb., vice M. BLICKENSDERFER resigned.

GEN. JOHN NEWTON, according to press rumor, will resign his present position of Commissioner of Public Works of New York, to accept the appointment of Supt. of the Coast Survey from President CLEVELAND. THOMAS F. GILROY is spoken of as his successor in the New York Department.

C. L. CROCKER, Third Vice President of the Southern Pacific, has been elected Second Vice President, to fill the vacancy made by the death of the late CHAS. CROCKER. A. N. TOWNE, General Manager, will now be Third Vice President and General Manager.

Dr. EMIL WINKLER, a famous German Engineer and professor in the Technical High School at Berlin, died on Oct. 27. It is proposed to erect a statue to Prof. WINKLER, and the *Centralblatt der Bauverwaltung* expresses the hope that his scholars, friends, and members of the engineering profession generally who have been benefited by his works on bridge construction, etc., will contribute towards this end. Subscriptions can be sent to the journal named above, at Berlin, Germany.

ROSS KELLS, Assistant Superintendent of Motive Power of the N. Y., P. & O. division of the Erie, has had his jurisdiction extended to cover all lines controlled by the Erie company. His office will remain at Cleveland. S. HIGGINS has been appointed Master Mechanic of the N. Y., P. & O. division at Meadville, Pa., vice W. LAVERY, promoted to be Master Mechanic of the Susquehanna division. A. W. BALL has been appointed Master Mechanic of the N. Y., P. & O. division at Galion, O., vice S. HIGGINS.

Mr. ALPHONSE FTELEY, the new Chief Engineer of the New Croton Aqueduct, is about 50 years of age, and is a native of France, and a graduate of the Paris Polytechnic School. Mr. FTELEY was associated with Mr. WM. E. WORTHEN, of New York, for some years, but in 1873 was appointed Resident Engineer of the "Additional Water Supply of the City of Boston", and in 1880 was Assistant City Engineer of Boston. His work in these positions is well known to engineers from his published data and experiments. At the commencement of the New Croton Aqueduct he was made Deputy Chief Engineer, and later Consulting Engineer, and the plans throughout bear the marked impress of his skill and experience as an engineer. Mr. FTELEY is a Director of the American Society of Civil Engineers, and next year will be one of its two Vice-Presidents.

JOHN MCLEOD, Chief Engineer of the Louisville Southern, has been appointed General Manager of that road. He was born at Georgetown, D. C., July 21, 1836. He entered the railway service October 13, 1853 and until March, 1855, was a rodman and levelman in the engineering corps of the Fredericksburg & Gordonsville road. From March, 1855, to October, 1865, he was on the location and construction corps of the Louisville & Nashville, being successively engaged as leveler, surveyor, resident and division engineer. In October, 1865, and until April 1869, he was principal assistant engineer of the Louisville, Cincinnati & Lexington. From April, 1869, until January, 1872, he was Chief Assistant Engineer of the Elizabethtown & Paducah road, and in the early part of 1872 was made Chief Engineer and Superintendent of the same road. From July, 1874, till August, 1876, he was General Superintendent of the Louisville, Cincinnati & Lexington; from August 4, 1876, to July 15, 1878, he was its Receiver, and from the latter date until 1880 he was the General Superintendent. From January, 1880, till 1884 he was General Superintendent of the Louisville, New Albany & Chicago road, and since 1886 he has been Chief Engineer of the Louisville Southern.

CORRESPONDENCE.

The Helena Collision.

Helena Pressed Brick Co.

HELENA. MONT. Oct. 31, 1888.

EDITOR ENGINEERING NEWS:

Enclosed I send you clipping descriptive of a terrible wreck which occurred 11 miles east of here, yesterday at 9 A. M.

It happened that the accident occurred directly in front of this company's brick works and as I arrived there shortly after, I was able to learn the exact particulars from my own employès, several of whom were eye witnesses of the whole affair.

The train men belonging to No. 17, the local freight which was standing on the *main* track, were beyond a doubt criminally negligent. Besides No. 13, which collided with them, and which they must have known was close behind them, No. 3, the local west bound passenger, was 7 hours overdue, and No. 1, the limited west bound, just due then at Clasoil station where the accident occurred. Had some one been sent back beyond the cut, which was on a curve, to flag coming trains, this terrible accident would have been averted but the train men of No. 17 preferred taking the chance for 15 or 20 minutes while switching, of trains which might come, rather than send a man back less than half a mile.

This is not a telegraph station; therefore they had no chance to learn just how closely other trains were following them, and therefore were *sure* of nothing.

The engine was completely wrecked, a total loss, and two cars besides the caboose of the standing train were smashed to splinters.

Yours truly, FRANK L. SIZER.

[This accident is a good illustration of the impossibility of getting "eternal vigilance" out of human beings, yet when companies which have neglected to supply mechanical or other substitutes therefor are confronted with some great wreck, both they and the public are too apt to think it a sufficient excuse to show "criminal negligence of employes" or "neglect of orders". ED. ENG. NEWS.

Last Summer's Floods in Mexico.

TEHUACAN, Pueblo, Mex., Oct. 23, 1888.

EDITOR ENGINEERING NEWS:

My copy of your paper of July 7, through a series of unfortunate delays, only reached me a few days ago.

I notice your editorial on the "Floods in Mexico" of last June. I was in Irapuato at the time these occurred, and, in common with the inhabitants of that place, passed an anxious night on account of them, but, contrary to the ideas you express, formed the opinion that they were not unprecedented, but were reached in 1855 and, probably, exceeded some 70 years ago.

My reasons were the following:

Irapuato, which probably lies lower in respect to its river than either Leon or Silao, is protected by a dyke. The water rose to the top of this dyke and was only prevented from going over it and flooding the town, no part of which is less than 2 meters below the flood line of that time, by hard work carried on through a whole night. This flood came from the water which had inundated Silao and a part of Guanajuato.

Now the existence of this dyke, at its height, proved that it had been erected to guard against just such a flood. But further, it was clearly evident that the dyke had been originally at least a half meter higher, and had been worn down by travel and the winds and rains of a long period of neglect. This flood was acknowledged to be about a half meter higher than that of 1855, but, mark this, since 1855 the Mexican Central Railway has been built, approximately parallel with the dyke, and with an embankment some 2½ meters high, which prevented the waters from extending eastward and held them up so that there was a difference in their level of from 60 to 70 centimeters on the two sides of it.

It seemed clear to me that if the waters could have extended freely eastward, the flood line would have been lowered at the dyke to, probably, the height of 1855.

Again the Rio Turbio received the water which had inundated Leon and the grade line of the Guadalajara branch of the Mexican Central at its crossing, adjusted to the height of the flood line of 1855, proved high enough.

My reason for thinking that the flood of 70 years ago was greater than that of June, was that the old inhabitants of Irapuato believed that it had the same height, it having had then the opportunity to extend freely eastward, as I described above.

I should add that the rains which brought on the inundations at Leon and Silao, extended to the south of Irapuato, and that several towns to the south of it suffered somewhat from inundations.

If you will analyze the reports from Leon and Silao, you will find accounts of the breaking of dykes at both places, and it is hardly to be doubted that these dykes had been neglected during the past 30 odd years of security.

Since the flood the people of Irapuato have raised their dyke again to about the height it must have been originally, and have also widened and strengthened it at some points. Yours truly,

JOHN E. EARLEY.

[There is, we believe, no record of any such serious disasters as resulted from last summer's flood in the way of destruction of life and buildings, nor anything approaching them, and a dyke is naturally built somewhat higher than past experience indicates is essential. Still, the reasons advanced are cogent. —ED. ENG. NEWS.]

The Bangor Dam.

KANSAS CITY, Mo., Nov. 3, 1888.

EDITOR ENGINEERING NEWS:

I notice in a recent issue of ENGINEERING NEWS the dam at Bangor, Maine, spoken of as "insignificant". As this dam required some 6,000 M. ft. B. M. of lumber, some 80,000 cu. yd. of rock filling and probably 4,000 cu. yds. of granite masonry, it did not occur to me in that light. Having had charge of the channel construction and finding some problems there that seemed to me of engineering interest I had thought of making a paper of them if I ever got time. I am glad I found out their insignificance beforehand. Yours truly,

G. W. PEARSONS.

[We spoke of the Bangor dam as "insignificant" only in respect to its height, and expressly stated its great length. It does not by any means follow that because a dam was small in height, it might not have had more interesting engineering features than many larger ones.—ED. ENG. NEWS.]

The Quaker Bridge Dam.

PHILADELPHIA, Pa., Nov. 3, 1888.

EDITOR ENGINEERING NEWS:—

In to day's issue you publish a very interesting editorial on the plans of the Quaker Bridge Dam It affords me a great pleasure to know that I am not the only one who found "strange errors of facts" in the report of the Board of Experts.

You will find enclosed a copy of the letters I had the honor to address to the Aqueduct Commission, since the appearance of their report. If you judge its contents to be of interest to your readers, I will be pleased to see it published in an issue of your valuable paper. Yours respectfully,

ARTHUR MARICHAL.

[The letter is one of some length to the Aqueduct Commission which it hardly seems appropriate for us to reproduce in full, as we must confess our inability to perceive the force of the "consequently" in the fourth paragraph below. It says, after objecting to an increase of radius from 900 to 1,200 ft.]:

"Speaking of the profile submitted by myself, your Board of Experts say that it would not be entirely safe. I will try to prove that on the contrary it is considerably stronger than the one proposed by your Board of Experts.

"The main danger in such a high masonry dam is the disintegration of the mortar by an excessive crushing strain near the inner toe.

"As soon as some disintegration has taken place the water, under the immense pressure resulting from its depth, finds an easy way through the masonry and scours the mortar with rapidity, thus causing a dangerous settling and objectionable counter pressure, having a tendency to decrease the stability of the structure.

"To calculate the pressure at the base, your Board of Experts has made assumption which can never be realized in practice. They have supposed that the dam was an unyielding mass, consequently more rigid than it would be if made of cast-iron, for instance; while on the contrary we know by experience that rubble masonry yields very much to pressure. The heaviest load will consequently not be at the toes, but will be near to a point vertically under the roadbed, and said crushing strain will be about 21 tons per sq. ft. at that place.

"In the profile proposed by the Board of Experts this maximum pressure will take place near the *inner toe*

while in the one proposed by myself the part A B, where the heaviest strain is likely to occur, is *near the center of the base*, thus avoiding any source of danger." * * *

"* * * (2) *When built on a curve of 100 ft. radius, as I proposed*, the dam will have an immense margin for safety and will be stronger than if built according to any of the plans submitted to date by your Board of Experts or others.

"(3) The area of the section is less than the area of any other proposed profiles.

"(4) The dam, built according to my plan, would cost at least $500,000 less than if built according to the plans proposed by your Board of Experts.—In case any of my claims should not seem perfectly clear, I would ask for the privilege of being heard on the subject."

Book Notices.

Statistical Abstract of the United States, 1887. Finance, Coinage, Commerce, Immigration, Shipping, Postal Service, Population, Railroads, Agriculture, etc. Prepared by Bureau of Statistics under the Secretary of the Treasury. Washington, D. C. Pub. Doc. pp. 254.

The immense mass of valuable information consolidated in this and other like publications which are given away for the asking is hardly appreciated by the general public, who do not realize how much good work of all kind there is done with the money they pay in taxes. Anyone with any interest in his country and any taste at all for statistics can spend half a day looking over this volume (if he have also the time) with great interest and profit. We propose abstracting a few of the most significant facts and figures.

Government expenditures per capita.

	0	1	2	3	4	5	6	7	8	9
1860	—	—	—	$21.42	25.42	37.34	14.68	9.87	10.21	8.55
1870	8.03	7.39	6.84	6.97	7.07	6.25	5.87	5.21	4.98	5.46
1880	5.34	5.07	4.89	4.90	4.39	4.16	4.15	4.47		

GOVERNMENT PUBLIC DEBT: 3 *per cents.* Began practically in 1883 with $318,600,000, reduced to $33,716,000 by 1888.

3½ *per cents.* $460,461,000 in 1882, paid off in 1884.

4 *per cents.* Small amount before 1879; nearly constant since at $738,000,000.

4½ *per cents.* Began in 1877; nearly constant since at $250,000,000.

5 *per cents.* At a maximum ($712,000,000) in 1876: all paid off in '81.

6 *per cents.* At a maximum ($1,878,000,000) in 1868; reduced one-half in 1876: all paid off in 1881.

7.3 *per cents.* A war device; $830,000,000 in 1865: all paid off in 1868.

Total interest bearing debt. At a maximum Aug 31, 1865, $2,381,530,295, with $150,977,698 interest; July 1, 1887, $1,021,692,350, with $41,730,520 interest, a large volume of 4 and 4½ per cents. not being payable. It has since been reduced over $100,000,000.

Interest charge per capita; maximum $4.29 now 70 cts.

Official estimate of population, July 1, 1877, 60,018,000, at which amount it has increased at the rate of 29.23 per cent. since 1880 and the indicated population for July 1, 1889, is 63,100,000, and for July 1, 1890 (census date) 64,820,000. We anticipate that this estimate will prove too small.

State, County and Municipal Debts, 1886. Aggregate per head.

[We reclassify the States by groups.—ED.]

New England.		*Middle.*		*So. Atlantic.*		*Gulf.*	
Me.,	$34.53	N. Y.,	$43.03	Va.,	$27.83	Ala.,	$11.67
N. H.,	31.90	N. J.,	43.80	W. Va.,	2.45	Miss.,	1.78
Vt.,	13.10	Pa.,	26.63	No. Ca.,	5.85	La.,	45.60
Mass.,	51.19	Del.,	16.01	S. Ca.,	13.41	Tenn.,	24.25
R. I.,	47.38	Md.,	11.65	Ga.,	12.76	Ky.,	9.08
Conn.,	35.33	D. C.,	127.66	Fla.,	9.75		

So. W.		*No. Cent.*		*N. W.*		*Pacific.*	
Mo.,	$26.48	Ohio,	$15.24	Ia.,	$4.90	Wash.,	$3.19
Ark.,	9.89	Ind.,	9.28	Minn.,	10.86	Ore.,	4.86
Tex.,	7.29	Ill.,	14.68	Neb.,	16.41	Cal.,	19.38
Kan.,	16.07	Mich.,	5.38	Dak.,	7.39	Nev.,	16.45
Col.,	18.49	Wisc.,	9.03	Wyo.,	9.88	Ariz.,	9.33
N. M.,	0.71			Mont.,	19.41	Utah,	0.81
						Id.,	7.22

Total U. S., $21.07.
National, 19.58.

The aggregate of State debts has decreased since 1880 from $234,257,000 to $217,593 000, and it is probable that the same is the case with county and municipal debts.

	Exports.	Imports.	Av. duty p. c.	p. c. free.
1791	—	29.2	15.34	—
1800	—	91.2	17.42	—
1810	—	85.4	14.07	—
1820	—	74.4	26.89	3.7
1830	—	62.7	61.69	7.3
1840	132.1	98.3	34.39	48.7
1850	151.9	173.5	27.14	10.5
1860	400.1	353.6	19.67	20.8
1870	450.9	436.0	47.08	4.2
1880	852.8	668.0	43.48	31.2
1887	752.2	692.3	47.10	33.8

Exports and imports are given with great fullness from 1790. A decennial abstract is given in the preceding table (1 = $1,000,000).

The average duty is on the dutiable goods only. The per cent. of free goods we have computed.

The statistics of exports and imports and of banking are given with the greatest fullness for each leading item separately, but too fully for us to abstract. Gold and silver production in millions of dollars, by half decades since 1850 has been as follows:

	Gold.	Silver.	Total.
1850	50.00	0.65	50.65
1855	55.00	0.55	55.55
1860	46.00	0.15	46.15
1865	53.22	11.25	64.47
1870	50.00	16.00	66.00
1875	33.47	31.73	65.20
1880	36.00	39.20	75.20
1885	31.80	51.60	83.40

The production of gold, which until 1860 was wholly in California, is now 60 per cent. of it in other States.

The value of manufactured cotton exports has increased from about $4,000,000 in 1870, regularly to $15,000,000 in 1887. The pounds of wool produced has increased from 142,000,000 lbs. in 1864 to about 305,000,000 lbs. in 1886 and the imports from 186,000,000 lbs. to 400,000,000 lbs.

Pig iron production has increased lately at this marvellous rate, in spite of a *decrease* in the number of furnaces from 698 in 1878 to 582 in 1887:

	Penn. only, 2,000 lb. tons.	Total tons.
1878	1,342,663	2,577,361
1879	1,607,763	3,070,875
1880	2,083,121	4,295,444
1881	2,190,786	4,641 564
1882	2,449,256	5,178,172
1883	2,638,891	5,146,972
1884	2,385,402	4,589,615
1885	2,445,496	4,529,869
1886	3,293,289	6,365,329

The production is still rapidly rising, being now at a greater rate than the English output. The imports are under 400,000 tons and the exports only 8,000.

Wheat production has about doubled since 1867, an average crop being now 450,000,000 bu. About 30 per cent. is ordinarily exported.

Corn has considerably more than doubled since 1867 to an average crop of about 1,800,000,000 bu., only some 3 per cent. of which is exported.

Petroleum, despite Russian competition, is an increasingly important product and export.

The figures are in millions of gallons:

	Product.	Exports.
1865	101.8	25.5
1870	185.3	113.7
1875	423.5	222.0
1880	950.1	424.0
1885	913.5	574.7
1887	1084.3	592.8

The consumption of alcoholic drinks in gallons per head has changed in this remarkable fashion.

	Distilled.	Wines.	Malt.	Total.
1860	2.86	0.35	3.22	6.44
1870	2.07	0.32	5.31	7.70
1880	1.27	0.56	8.26	10.09
1887	1.19	0.55	11.98	13.68

The absolute quantity of alcohol consumed has not greatly fallen off, although it has somewhat; but the form in which the alcohol is taken has greatly improved.

The immigration table showing the arrivals by countries from 1874 to 1887 is full of interesting matter, which we can hardly attempt to abstract. The annual rate from Great Britain is about 50 per cent. greater, and less from Ireland than from the main island. The annual rate from Germany is only about 20 per cent. greater. Austria and Hungary, Sweden and (we regret to say) Italy, show a great increase in rate to a nearly equal present rate of 40,000 to 50,000. Russia also shows a rapidly increasing rate from little or nothing to 30,000. Chinese immigration was happily nipped in the bud in 1882, when it had reached by rapid jumps an annual rate of about 40,000, which by this time would surely have been 100,000 and in a fair way to drown us out. Never was an apparently illiberal law wiser or more timely. The rest of Asia and Africa send us hardly a handful. As an average the normal immigration rate may be said to be now nearly 500,000 per year, which is a far larger dose than even our excellent digestion can properly take care of.

Our foreign commerce makes a pitiable showing, the total *foreign tonnage only* having been as follows in thousands of tons:

	British.	American.	All other	Total.
1860	1,763	3,392	425	5,000
1865	1,788	1,613	424	3 827
1870	2,792	2,452	1,026	6,270
1875	4,017	2,887	2,239	9,143
1880	7,931	3,140	4,160	15,251
1885	6,224	2,709	3,354	12,287
1887	7,109	2,871	3,552	13,532

The most notable increase is in "all other", all the Continental countries showing a healthy increase, but our own showing a tendency to steadily grow worse. Our total sailing tonnage since 1870 has decreased from 3,171,412 tons to 2,563,128 tons. Our steam tonnage shows the paltry increase from 1,075,095 to 1,542,717.

The tables showing the foreign and coastwise sail and steam shipping, whale fishers, cod fishers, etc., for each year from 1789 is exceedingly interesting. By decades since 1850 it has stood as follows, in thousands of tons:

	Foreign Trade.	Coasting Trade.	Whale fishing.	Cod, etc., fishing.	Total Sail.	Steam.
1850	1,440	1,798	146	152	3,010	526
1860	2,380	2,615	167	163	4,486	868
1870	1,449	2,638	68	91	3,171	1,075
1880	1,314	2,638	38	78	2,856	1,212
1887	989	2,929	26	80	2,563	1,543

Of the total area of the United States, 2,300,000,000 acres, there are still 842,000,000 acres, or much over one-third, unsurveyed, chiefly in the Rocky Mountains and arid plains surrounding them, a large part of which will yet be made to blossom like the rose by irrigation, but which is now useful for grazing only, if at all.

The statistics of the Post-Office Department, Schools and Colleges, Railways and Rates (chiefly from Poor) Telegraphs, Crops, etc., etc., we have no space left to abstract. One curious table of Pension Statistics shows that the number of pensioners is now 406,007, or about double what it was in 1871, the amount drawn having increased from $33,000,000 to $74,815,000. Since 1884 there has been an increase of 83,000 pensioners and $17,600,000 annual expenditure.

SOCIETY PROCEEDINGS.

American Society of Civil Engineers.—At the regular meeting on Nov. 21, Vice-President J. J. R. CROES in the chair, the Secretary read a paper by C. D. PURDON on the "Construction of the Bridge over the Arkansas River at Van Buren, Ark." There are 10 masonry piers, including the abutments, and the pivot pier of the 360 ft. draw span is 30 ft. diameter. The trusses are all of the single intersection type, 18 ft. apart. The total length of the bridge is 1,798 ft. The foundations were built by Sooysmith & Son, of Chicago, and the masonry and superstructure by the Union Bridge Co. The paper was very complete, entering fully into the details of construction. The caisson of pier No. 3 caused considerable trouble by getting out of line, and the description of the methods employed to right it and get it back into place gave rise to an interesting discussion on the means of controlling the position of caissons while being sunk.

Mr. MACDONALD referred to the Hawkesbury bridge (in Australia), one of the caissons of which was found to be about 7 ft. out of line, at right angles to the center of the bridge, when it was 130 ft. down in the mud. It was got back about 3 or 4 ft. by anchoring the top to an artificial island in the river, and then dredging deep under the down stream side of the cutting edge of the caisson while loading that side with concrete and masonry; in this way the caisson was given a tendency to work back while sinking. He called particular attention to the absolute necessity of keeping the dredging below the cutting edge and of not overloading the concrete pockets.

Mr. SOOYSMITH described different methods of moving caissons.

Mr. CLARK referred to the piers of the Poughkeepsie bridge, the caissons for which gave no trouble by getting out of line while being sunk.

There was also some discussion with regard to the respective merits of vertical or inclined sides for the caissons. Mr. MACDONALD stated that a certain bearing area of the bottom was required, and it seemed worth while to save material by reducing the size upwards by means of a batter. As to the effect of the different forms upon the action of the caisson while being sunk, opinions differed, and nobody could say really what effect the form does have.

American Forestry Congress.—The Seventh Annual Meeting will be held at Atlanta, Ga., Dec. 5, 6, 7, 1888. The subjects which will be specially considered at this session of the Congress are: Legislation needed in behalf of the timber lands belonging to the United States; need of State Forestry Commissions and their proper sphere of

action; methods desirable for educating the public mind in regard to forestry. Papers and addresses on these and other subjects pertinent to forestry are promised, and others are solicited. Their title should be sent to the secretary for proper classification at least one week before the meeting. B. E. FERNOW, Washington, D. C., is secretary.

Civil Engineers' Club of Cleveland, O.—At the meeting on NOV. 12, JOHN WHITELAW in the chair, a paper on "Recent Applications of Electricity" was read by N. S. POSSONS, Superintendent of the Brush Electric Co.

Western Railway Club.—At the meeting in Chicago, Nov. 20, the subjects for discussion were "Combustion" and "Wheel and Axle for 60,000 lbs. cars; Size and Quality". A paper on "The Use of Iron as a Material for Cars" was presented by G. W. ETTENGER.

CONSTRUCTION NEWS.

RAILROADS.

East of Chicago.

Existing Roads.

Hereford.—The trouble with the unpaid Italian laborers on this road broke out anew on Thursday, Nov. 15. The strikers obtained possession of two locomotives, cut away a trestle bridge, and tore up some track. The militia were called out and the strikers were dispersed. The railway company refused to have anything further to do with them, and as most of them left the country no further trouble is apprehended.

Cleveland & Canton.—Work on the change of gauge on this Ohio road began Tuesday morning, Nov. 18, and the work was completed in 12 hours. On the division between Cleveland and Canton, new heavy steel was laid each side of the old narrow gauge track; but on the remainder of the line the old rails were spread. The company offer for sale their entire equipment of narrow gauge rolling stock, including 25 locomotives, 28 passenger cars and nearly 1,000 freight cars. The work of changing the gauge was under the direction of Chief Engineer H. A. KENNEDY. A public jubilee was held at Canton, on Nov. 22 to celebrate the event.

The Coshocton Southern extension from Coshocton to Zanesville is expected to be in operation by Feb. 1, 1889. The Cleveland, Chagrin Falls & Northern, which is to run from South Solon to Fairport, will be finished as far as Chagrin Falls, by Feb. 1, 1889. The South Pennsylvania & Ohio Railroad from Canton to Wheeling, W. Va., is expected to be finished by Jan. 1, 1890.

New York & New England.—The annual report of the company makes the following showing:

Gross earnings	$5,273,451
Operating expenses	3,511,090
Net earnings	1,762,360
Increase from 1887	14,488

The road and equipment is in better condition than ever before; but the motive power for freight movement is worked up to its full capacity and contracts are to be made at once for increased equipment. The small earnings for the year have been due to the March blizzard, which cost the company $60,000, and to the low rates on competitive traffic. The report says:

> The board has authorized and your officers have entered into a contract between this company and the Hudson Suspension Bridge & New England Railway Co. for the construction of a suspension bridge across the Hudson river, 4 miles above Peekskill, and of connecting roads in either direction to connect your company's road with the roads west of the Hudson river. We believe this to be a very important addition to the facilities for increasing the future growth of the business of your road. This contract will be submitted for your approval at the annual meeting.

Geneva, Ithaca & Sayre.—It is probable that this road will be placed in a receiver's hands at an early day. The stock of the company is principally held by the Lehigh Valley, which has from time to time advanced about $155,000 to make up the deficiency and pay the fixed charges. It now demands the repayment of this debt.

Baltimore & Ohio.—At the meeting of the stockholders at Baltimore, Nov. 19, seven new directors were chosen and seven were dropped from the board. The new men are AUBREY PEARRE, GEORGE DE B. KEIM, WESLEY A. TUCKER, MAURICE GREGG, J. WILCOX BROWN, WILLIAM G. ATKINSON and WILLIAM F. FRICK. The Directors who were retired are WILLIAM KEYSER, JAMES L. MCLANE, JOHN GREGG, GEORGE W. DOBBIN, JAMES CAREY COALE, G. A. VON LINGEN and ROBERT GARRETT. ROBERT GARRETT is succeeded by his father-in-law, WILLIAM F. FRICK, who now has practical control of all the GARRETT estates.

The report which has been in circulation that Senator GORMAN was to succeed President SPENCER is now acknowledged to be without foundation. It is altogether probable that Mr. SPENCER will retain his present position.

The annual report for the year ending Sept. 30, 1888, shows as follows:

Gross earnings	$20,353,491
Expenses	14,212,008
Net earnings	$ 6,141,482

A new schedule has just taken effect on the Philadelphia and Washington line and five through express trains leave Philadelphia every day for Baltimore and Washington. The train leaving Philadelphia at 8 A. M. is scheduled to make the run to Washington in 3¼ hours, which is claimed to be faster than any other schedule ever adopted between Philadelphia and Washington.

New Haven & Derby.—The Connecticut Board of Railroad Commissioners have approved the extension from Derby to Hawleyville, and it will be open for traffic Nov. 26.

Canada & St. Louis.—A construction train has been put on this new Michigan road and tracklaying is in progress from Battle Creek south.

New Projects and Surveys.

Chicago, Dayton & Cincinnati.

HUNTINGTON, Ind., Nov. 14, 1888.

EDITOR ENGINEERING NEWS:—

The Chicago, Dayton & Cincinnati Railway was chartered June 21, 1888, and is projected in the interest of the country it traverses. It is also especially in the interest of the Chicago & Atlantic at the west and the Dayton & Ironton on the east, as well as the Cincinnati, Hamilton & Dayton and the Cincinnati Southern. The main feature of the enterprise is the connection it will furnish between the Ohio coal fields and Chicago.

Several routes have been surveyed for our road and the question of which will be adopted will probably be determined by the matter of local aid. The route most favored extends from Huntington, *via* Bluffton and Geneva, Ind., to Versailles, O., a distance of 65 miles. The maximum grade is 26 ft. per mile and there is no excavation or fill over 6 ft. There are no curves except for running into the several towns along the route. The country is unusually favorable for construction. There is only one bridge.

Right of way is not yet secured, but much has been offered in aid of the enterprise and local aid has been secured to the amount of $200,000. The line will probably be put under contract next May. Col. GEO. G. PRIDE, Huntington, Ind., is our Chief Engineer.

L. P. MILLIGAN, *President.*

Columbia & Rensselaer.—

HUDSON, N. Y., Nov. 15, 1888.

EDITOR ENGINEERING NEWS:—

The Columbia & Rensselaer Railroad has been located, and work is expected to begin on construction shortly.

JOHN M. PEARSON.

Cleveland & Southern.—The Cleveland *Leader* says that this project is in a fair way to be realized soon. The route of the lines is from Cleveland almost due south through Royalton, along the dividing line of Medina and Wayne counties through Doylestown, Coshocton, and Zanesville and on south to Burlington, Lawrence county, the southernmost point in Ohio. It strikes coal lines throughout almost its entire length. It is then proposed to continue the line across the river through the finest undeveloped coal field of West Virginia to Pocahontas, Va., there to connect with the Norfolk & Western road.

Massillon & Canton.—Dow & Jones, the brokers, have sent out the following item: Governor WARWICK, of Ohio, is about to build a line from a connection with the Wheeling & Lake Erie at Massillon to Canton, thence east to New Lisbon and Rogersville.

Elkhart & Western.—

ELKHART, Ind., Nov. 14, 1888.

EDITOR ENGINEERING NEWS:

The Elkhart & Western Railway is to run from Elkhart to the north side of the St. Joe river, a distance of 10 miles. The surveys are all made and the line secured is almost a water level, straight, and easy grading. Right of way has been secured for about ¾ of the distance at a cost of about $1,000 a mile. Capital for building is not yet secured. H. E. BUCKLEN, 275 Michigan Ave., Chicago, Ill., is President.

E. C. BICKEL,
Sec. and Acting Chief Engineer.

Detroit River Tunnel.—A company has been organized at Detroit, Mich., to construct a tunnel under the Detroit river to connect the Canadian railways with the lines entering Detroit. LUTHER BEECHER, a Detroit capitalist, is at the head of the enterprise.

Utica & Unadilla Valley.—This company has been chartered in New York to build a railway from Bridgewater to New Berlin, about 20 miles. ALBERT C. COUCH, of Utica is President and DELOS E. CULVER is Treasurer.

North Attleboro & Wrentham.—The Massachusetts State Board of Railroad Commissioners has refused to grant a certificate of exigency for the line proposed by this company. The line over a similar route surveyed by the Old Colony company was approved, however. The board held that public interest would be better served if the Old Colony company built and operated the line at a cost on the capital invested of but 4 per cent., than if an independent company built the line, paying a higher rate of interest.

SOUTHERN

Existing Roads.

Eutawville.—A contract is to be let at once for a division of 15 miles on the extension to Sumter, S. C. and surveys are to be made for an extension from Sumter north to Cheraw, on the Seaboard & Roanoke system. R. C. BARKLEY is President of the company; ISAAC W. FOWLER, General Manager, and H. T. PEAKE, Chief Engineer.

Atlantic & Danville.—The city of Danville, Va., has voted to extend the time for the completion of this road to that city necessary to secure the city subscription of $150,000, from May to December 1889.——It is stated that this road, the Danville & New River west from Danville, and the New York, Philadelphia & Norfolk on the southern Maryland peninsula, are to be operated in harmony as a single system.

Americus, Preston & Lumpkin.—The locating survey is nearly finished on the extension from Abbeville to Savannah, which is to form part of the Central Railroad of Georgia system. The corps in charge of W. W. CAMPBELL of Tuskegee, which is making the survey for the extension to Montgomery, Ala., will reach that point next week. The consolidation of the Central system with the Richmond Terminal is not expected to alter the plans which had been decided upon for the early completion of these extensions.

Pensacola & Memphis.—The Pensacola (Fla.) *Commercial* publishes an interview with Chief Engineer and General Manager J. W. GALLUP, in which he states that the chief financial backers of the enterprise have purchased nearly all the stock held by the original promoters and intend to put a large force on construction at an early day. The only parties now interested in the company who were with it at its start are the WRIGHTS of Pensacola, and J. H. WRIGHT and Walker & Hall of Meridian, Miss. Among the present backers of the company are Senator PAYNE, of Ohio; A. W. JOHNSON, of Boston, President of the company; and G. H. KIMBALL of Cleveland, O., Supt. of the eastern division of the New York, Chicago & St. Louis (Nickel Plate) Railroad, who is directing the preliminary work.

Northwest & Florida.—Tracklaying on the southern extension of this Alabama road has been completed to Luverne, and trains are now running to that point.

Chattanooga, Rome & Columbus.—A charter will be asked of the Georgia Legislature to permit the building of extensions to Atlanta, Columbus and Montgomery.

Kentucky Midland.—JOSEPH ROBINSON, of the engineering staff of this road, is engaged in securing right of way for a line from Frankfort to Lawrenceburg to connect this road with the Louisville Southern. It is thought that construction will begin on the branch at an early date.

West Virginia Central & Pittsburg.—A meeting of the board of directors was held at Baltimore on Nov. 13 and President H. G. DAVIS submitted a report for the 10 months ending Oct. 31. The net earnings above fixed charges were $65,692. This notwithstanding that the losses experienced by the heavy floods of last summer increased the operating expenses by $60,000. The Cheat extension, from Thomas to Leadsville, Randolph county, W. Va., 35 miles, is well under way and will be finished by next spring. The Abram's Creek branch to the Elk Garden Mines, 7 miles in length, will be finished in December. The connection with the Baltimore & Ohio at Cumberland, Md., has been finished and freight is now transferred to the company at that point. The rolling stock has been increased by the purchase of 4 locomotives and 266 cars and great improvements have been made on the roadbed.

Chesapeake & Ohio.—Extensive improvements are to be made by the company on their terminals at Newport News in expectation of a heavy increase of traffic with the opening of the new line.——A party of capitalists including, JOHN JACOB ASTOR; JOHN A. STEWART, President of the United States Trust Co.; GEO. BLISS, of Morton, Bliss & Co.; and representatives of the banking firms of Drexel, Morgan & Co. and Brown Brothers & Co., have been making a tour over this road during the past week accompanied by President M. E. INGALLS.

Nashville & Knoxville.—A large force is at work laying the rails from Carthage to Gordonsville, Tenn., and it is expected to reach that point by Dec. 15.

Kentucky.—The State Board of Railroad Commissioners have completed their assessment of the railroad lines of Kentucky and report a total amount of 2,371 miles, the assessed value of which is $39,873,285.

Richmond & West Point Terminal.—One of the biggest checks that Wall Street has seen in a long time was drawn upon the Central Trust Co. this week by President JOHN H. INMAN. It was for $3,950,000, and was the final payment for the control of the Central Railroad & Banking Co., of Georgia.——President INMAN has written to the Atlanta *Constitution* stating that the Richmond Terminal managers intend to establish a special bureau for the aid of a new manufacturing and mineral enterprises everywhere along the lines of the system. He denies that the company is hindering the building of other railways in the South or that they intend to lease or purchase the Western & Atlantic.——A bill has been introduced in the Georgia Legislature to prevent consolidations of Georgia companies with companies outside that State. It imposes a penalty of ten years' imprisonment upon presidents, directors and operating officers of Georgia railroads who submit their properties to the convenience or business schemes of outsiders. The same penalty is to apply to those who combine within the State.

Louisville & Nashville.—The new shops of the company at Decatur, Ala., are to be pushed to completion

a large increase having been made in the number of hands engaged on their construction. This finally settles the rumor that they were to be built at Birmingham instead of Decatur.

Richmond & Chesapeake.—The stoppage of work on the tunnel which this company is building at Richmond, Va., is now explained to have been due to difficulty between the construction company and the contractors, J. C. Carpenter & Co. The differences having been settled, work is to be resumed and the tunnel will be completed by the date specified in the Richmond City ordinance.

Georgetown & Western.—Suit has been commenced for the appointment of a receiver for this South Carolina railroad.

Ohio Valley.—Work on the extension to Hopkinsville, Ky., is to be pushed at once; and it is expected to have cars running to Hopkinsville by next May.

New Projects and Surveys.

Midville, Swainsboro & Red Bluff.—This company has been chartered in Georgia and will extend to Red Bluff the Midville & Swainsboro logging railroad, owned by Jesse Thompson & Co., of Augusta, Ga.

Atlanta & Alabama.—The preliminary survey began at Selma, Ala., on Nov. 19.

Owensboro, Falls of Rough & Green River.—The owners of the Louisville, St. Louis & Texas are said to have taken up this Kentucky project and intend to push it through to an early completion. Subcontracts for grading are now ready to be let.

Cincinnati & Birmingham.—The Tullahoma, Tenn., correspondent of the Nashville *American* states that this project has not been abandoned, as many people have supposed. The officers of the company, who were empowered at the meeting of the original projectors over a year ago to take such steps as they deemed necessary to get the enterprise on a sound footing, state that they now have "a bona fide proposition from a powerful railroad syndicate to build the road, if the citizens along the line will subscribe to the company's capital stock to the amount of $1,000,000 as an earnest of their desire to have the road and of their friendliness to it." The total cost of the proposed road is estimated at $10,000,000. It is to extend from Somerset, Ky., south to some point in northern Alabama. M. R. CAMPBELL of Tullahoma, Tenn., president of the company, is now in New York in the interest of the enterprise.

THE NORTHWEST.

Existing Roads.

Duluth, Red Wing & Southern.—The annual meeting of this company was held at Red Wing, Minn., on Nov. 14. The old officers were reelected. It was voted to continue the work of construction both north and south. Grading is to be pushed during this winter and it is hoped to have trains running from Red Wing to Albert Lea by May 1, 1889.

Deadwood Central.—Grading is in progress on this Dakota road from Deadwood to Lead City and engineers are locating the extension beyond this point.

Chicago & Northwestern.—It is reported that a corps of surveyors are running a line for an extension of this system from Freeport to Galena, Ill. As there are already two direct lines between these cities, the Chicago, St. Paul & Kansas City and the Illinois Central, it is hardly likely that the line will be built.——The emphatic announcement of President MARVIN HUGHITT that if rate cutting was not stopped, the Chicago & Northwestern would reduce rates and keep them down till its competitor's received ample punishment seems likely to have a salutary effect in bringing about a settlement of the rate wars in the Northwest.

Chicago, Burlington & Quincy.—It is stated that this company is adding to its engineering staff and proposes to start work at once on the construction of about 350 miles of extensions in western Nebraska. It would seem rather unlikely, however, that much new construction will be done on these blizzard swept prairies before next spring.

New Projects and Surveys.

Yankton, Norfolk & Northwestern.—This company has been chartered in Nebraska and proposes to build a railway from a point opposite the city of Yankton, Dak., to the city of Norfolk. The incorporators are JAS. H. TELLER, JOHN T. M. PIERCE, W. H. H. BEADLE and EDWIN H. VAN ANTWERP.

St. Paul, Black Hills & Pacific.—A party under charge of J. W. ANDREWS is reported to be at work on a survey from Sturgis to Galena, Dgk.

Nebraska & Western.—F. A. HILL of Sioux City has made a survey from this proposed road from Sioux City, Ia., west about 200 miles.

THE SOUTHWEST.

Existing Roads.

Natchitoches.—An offer has been made to the company by Boston and New York capitalists to furnish funds for extending the road as originally contemplated from Natchitoches, La., north to Shreveport.

Kansas City, El Paso & Mexican.—Tracklaying has begun on this road at El Paso, Tex., and the first ten miles will be finished very speedily. The artesian well which was sunk, has struck a good vein of water, and others are to be put down all along the line of the road.

Fort Worth & Rio Grande.—It is again stated that capital has been secured for building the extension from Granbury, Tex., southwest and that work is to begin soon.

Kansas City, Wyandotte & Northwestern.—Contracts have been let for grading the extension from Seneca to Beatrice, Neb., a distance of 40 miles, and it is to be ready for the rails by Jan. 1.

Kansas.—The Board of State Railway Commissioners has addressed a circular letter to the General Managers of the railway companies doing business in the western part of the State asking that rates on lines in that section be reduced on account of the failure of the corn crop in that section and the consequent poverty of the farmers.

Atchison, Topeka & Santa Fè.—The employés of the company at Topeka recently adopted the following resolutions:

WHEREAS. The management of the Atchison, Topeka & Santa Fé Railroad Company has determined to make certain reductions in the salaries of its officers and employés who receive over $50 per month, on account of the diminution of its earnings, resulting from diminished traffic: and

WHEREAS. The employés affected by this reduction, appreciating the necessities which have caused such reduction in salaries, desire to express their fidelity and loyalty to the company's interests in this emergency; therefore,

Resolved, That the employés of the Atchison, Topeka & Santa Fé Railroad Company, in this meeting assembled, mindful of the liberal policy which has characterized the management of the Atchison company, do hereby express their cordial acquiesence in the step that has been taken, believing that the same is for the best interests of the company; and

Resolved, Further, that we do hereby express to the company our steadfast devotion to its interest, and our earnest faith in the justice and wisdom of the management in protecting its interests; and

Resolved, Further, that we hereby assure the company that we accept the reduction of salaries in the full belief that in the earliest practicable moment they will be restored to their former basis, and that while retrenchment and economy are required, we shall be found cheerful and ready to assist to the utmost of our power to that end.

The company has asked the engineers, firemen and switchmen to voluntarily submit to a 10% reduction for three months. The enginemen whose headquarters are at Topeka have voted to accept the reduction by a vote of 42 to 2: but the runners on other divisions are opposed to the project.——It is now generally believed that an agreement has been reached among the competing Southwestern systems which will result in the improvement of rates.

New Projects and Surveys.

Kansas City & Blue Valley.—This company has been chartered in Missouri to build a railway from the corner of Blue Avenue and Kensington St., in Kansas City to the western limits of the city of Independence. The incorporators are: Dr. Morrison Mumford, Thos. J. Greer, L. E. Davison, E. M. Holmes and A. D. Leach.

Kansas City & Platte City.—A project is on foot at Kansas City to build a dummy railway to Platte City about 20 miles. Surveys are to be made soon.

Stuttgart & Arkansas River.—This company has been chartered in Arkansas by W. F. DARELL of Little Rock, A. D. SWAN of Stuttgart, O. E. OVERTON of Bernadotte, Ill., and others, to build a railway from near Stuttgart to Arkansas Post, a distance of 45 miles.

Little Rock & Alexandria.—It is rumored that this company have secured the necessary capital to build their road and that active operations will commence at once.

ROCKY MOUNTAIN & PACIFIC.

Existing Roads.

Kansas City, El Paso & Mexican.—Tracklaying began on this road at El Paso, Tex., Nov. 16. About 16 miles are graded. The contract for tracklaying has been let to F. E. Nelson. The first 10 miles are to be finished by Dec. 1.

Mexican National.—It is reported that McCarthy & Kerrigan, of Little Rock, Ark., have been awarded an $8,000,000 contract by the Mexican National Construction Co.

Astoria & South Coast.—Chief Engineer HENRY B. THIELSEN has awarded the contract for clearing the right of way through the Skipanon woods to E. Lund & Co., a $175 per acre.

Mexican Central.—Work is being actively pushed on the San Luis Potosi and Tampico branch. The strike on the Guadalajara branch has ended. Through rates over the road are being reduced to meet the competition of the Mexican National.

Oregon Pacific.—The tracklayers have reached Mehama and intend to lay the rails to Brightenbush by Jan. 1.

Southern Pacific.—About 1,400 additional hands have been put at work on the Templeton extension. The Fresno & Tulare is to be finished to Poso at once.——The company intend shortly to put on a vestibule train between Council Bluffs and San Francisco to be known as the "Oriental Limited," making one round trip per week.

New Projects and Surveys.

San Domingo.— The Government has granted a valuable concession to OGDEN P. PELL and C. V. SIDELL, 146 Broadway, New York City, for the construction of a railway from San Domingo City to the city of Azua, about 100 miles. A subsidy is given of $2,000 per mile in cash besides a large land grant.

Aspen Short Line.—This company has been organized in Colorado to build a cut off for the Colorado Midland company about 12 miles in length near Leadville, by which a heavy grade is avoided. H. P. ROGERS, CHAS. E. NOBLE, E. F. DRAPER and others are the incorporators.

Emery County.—Incorporated in Utah to build a railway from coal mines to the Denver & Rio Grande Western. The capital stock is $40,000. A. H. SWAN, Cheyenne, Wyo., W. R. WILLIAMS, Ogden, Utah, and others are the incorporators.

Utah & Eastern.—A press dispatch from Cheyenne, Wyo., states that a large party of surveyors have just gone north to Ft. Fetterman, where they are to divide and work east and west.

Manitou & Pike's Peak.—Incorporated in Colorado by JOHN HULBERT, ALBERT E. PATTISON and others to build a rack railway by the summit of Pike's Peak. Among the directors of the company are President D. H. MOFFATT of the Denver & Rio Grande and President R. R. CABLE of the Chicago, Rock Island & Pacific.

Proposals Open.

Sewers.—Branch sewers. LOUIS WAGNER, Director o Public Works, Philadelphia, Pa. November 26.

Street Work.—Trinidad asphalt pavement; granite block pavement. THE COMMISSIONER OF PUBLIC WORKS, 31 Chambers St., New York City. November 27.

Pipe and Pipe Laying.—Cast-iron water pipe, 640 tons and 440 tons of straight pipe; also 60 tons of branch pipes and special castings; laying mains. THE COMMISSIONER OF PUBLIC WORKS, 31 Chambers St., New York City. November 27.

Sewers.—Concrete, rock excavation, receiving basin, 500 ft. of 28-in. brick sewer. MARTIN FINCK, Clerk of Board of Public Works, Jersey City, N. J. December 3 and 10.

City Work.—Excavating, grading, etc.; 15-in. pipe sewer. THOS. J. LANAHAN, Clerk of Board of Contract and Apportionment, Albany, N. Y. December 3.

Pier Work.—Repairing and building a new dumping board on the pier at the foot of W. 47th St., North River. THE DOCK COMMISSIONERS, Pier A, North River, New York City, (Nov. 30) December 4.

Street Work.—Regulating, grading, curbing, flagging sidewalks, granite block pavement. THE COMMISSIONER OF PUBLIC WORKS, 31 Chambers St., New York City. December 5.

Fencing.—Boards of 1-in. white oak, 6 ins. wide, 4 ft. long, placed vertical and cut diagonally at top; board lengthwise at bottom 9 ins. wide and 3 ins. from the ground; all securely nailed to 3 x 4 rails mortised into straight locust posts not less than 5 ins. at the small end, set 2½ ft. in the ground, and standing 4½ ft. above. E. R. WOODWARD, Roanoke, Va. December 12.

Dam, Tunnel, Etc.—For building a reservoir and dam on Byram river, and a tunnel and channelway to convey the waters of the Byram river into Kensceo reservoir in the town of North Castle, Westchester Co., N. Y. THE COMMISSIONER OF PUBLIC WORKS, 31 Chambers St., New York City. December 13.

Foundations.—Excavation, concrete and brick work. THE NEW CITY HALL COMMISSIONERS, San Francisco, Cal. December 15.

GOVERNMENT WORK.

Sectional Boilers.—Sectional water-tube steam boilers EDWARD CLARK, Architect of the Capitol, Washington, D. C. December 1.

Steam Heating Apparatus.—Low pressure return circulation steam heating and ventilating apparatus for U. S. building at Marquette, Mich. WILL A. FRERET, Supervising Architect, Treasury Department, Washington ,D. C. December 1.

Dredging.—Appomattox river improvement; about 5,000 cu. yds. Lieut. G. J. FIEBEGER, U. S. Engineer Office, Norfolk, Va. December 4.

Breakwater.—At San Luis Obispo harbor, Cal. Major W. H. H. BENYAURD, U. S. Engineer Office, San Francisco, Cal. December 6.

Dredging.—Dredging and rock excavation at Ashtabula harbor, Ohio. Major L. COOPER OVERMAN, U. S. Engineer Office, Cleveland, O. December 7.

Dredging and Breakwater.—Dredging at Norwalk harbor, Conn.; Thames river, Conn.; Milford harbor, Conn.; breakwater at Port Chester, N. Y. Lieut. Col. D. C. HOUSTON, U. S. Engineer Office, New York City. December 13.

Dredging.—About 700,000 cu. yds. of soft material in ship channel, Galveston bay. Major O. H. ERNST, U. S. Engineer Office, Galveston, Tex. December 17.

Breakwater.—About 400 lin. ft. of extension to the breakwater at Burlington harbor, Vt.; 19,520 ft. B. M. of pine timber; 321,068 ft. B. M. of hemlock timber; 20,232 cu. yds. of rubble stone; 2,110 cu. yds. of large stone, 1 to 5 tons weight; 4,375 lbs. of screw and washer bolts; 41,196 lbs. of drift bolts. Major M. B. ADAMS, U. S. Engineer Office, Burlington, Vt. December 20.

Contracting.

Levees.—The State Board of Engineers, New Orleans, La., has awarded contracts as follows: Raccourci, Morgan O'Connell, 11 cts. per cu. yd.; Bagatelle, A. L. Gervin, 13 cts.; South Side, John Cleary, 15 cts.; St. Sophia, John Cleary, 11.99 cts.

Pumping Engines.—The Volker & Felthousen Mfg. Co., of Buffalo, N. Y., has been awarded the contract for two duplex, compound, condensing engines of 1,000,000 galls. daily capacity each for the new water-works at Greenville, Tex. Condensers are to be attached to each engine. The engines will be center packed.

Government Work.—*Dredging and Revetment.*—Proposals for constructing extensions of the Carrollton revetment and beam wall, and for dredging the channel of the Saginaw river above Bay City, were opened Nov. 14, by Col O. M. POE, U. S. Engineer Office, Detroit, Mich. Only two proposals were received, and the prices in place were as follows: Carkin, Stickney & Cram, of East Saginaw, Mich., 36,000 lin. ft. of Norway pine piles, 12 cts. per lin. ft. in place.; Luther E. Allen, of Charlevoix, Mich., 16 cts.; 36,000 ft. of black ash piles, 11 cts. and 16 cts. per lin. ft.; 116,000 ft. B. M. of white pine timber, $30 and $26 per M.; 62,000 ft. B. M. of white pine plank, $30 and $21; 126,000 ft. B. M. of hemlock plank, $16 and $14.50; 7,200 lbs. screw and washer bolts, 7 cts. and 5 cts. per lb.; 6,000 lb. of drift bolts, 4 cts. and 3.6 cts.; 1,400 lbs. of spikes, 5 cts. and 4 cts.; 9,800 lbs. of cut nails, 5 cts. and 3½ cts.; 1,500 cords of slabs and edgings, $2 and $2.50 per cord of 128 cu. ft.; 250 cords of stone, $6.50 and $10 per cord; 1,300 cu. yds. of clay or gravel filling, 50 cts. and 1 ct. per cu. yd.; 10,000 cu. yds. of dredging, 43 cts. and 44½ cts. per cu. yd.; total with Norway pine piles, $22,541 and $23,624.40; total with black ash piles, $22,181 and $23,624.40.

Dredging.—These following proposals for dredging in the Saginaw river, (1) at West channel along West Bay City, and (2) bar at mouth, were opened Nov. 14 by Col. O. M. POE, U. S. Engineer Office, Detroit, Mich.: Chas. B. Curtis, West Bay City, Mich., (1) 28 cts. per cu. yd. scow measure; Hubbell & Skeldon, Detroit, (1) 28 cts., (2) 50 cts.; Quartus Gillmore, Loraine, O.,(1) 29 cts., (2) 49 cts.; John Hickler & Son, Sault Ste. Marie, Mich., (1) 35 cts., (2) 53 cts.; Carkin, Stickney & Cram, East Saginaw, (1) 36 cts., (2) 58 cts.; L. & J. A. Smith, Cleveland, O., (1) 40 cts., (2) 60 cts.; James Rooney, Toledo, O., (2) 58½ cts.

Dredging.—The following proposals for dredging in Duluth harbor and St. Louis bay have been received by Major J. B. QUINN, U. S. Engineer Office, Duluth, Minn.: Williams, Upham & Co., Duluth, 15 cts. and 15½ cts. respectively; C. S. Barker, Duluth, 16 cts. and 16 cts.; Knapp & Gillen, Racine, Wis., 17 cts. and 17½ cts.; Green Dredging Co., Chicago, 20 cts. and 20 cts. The contracts, amounting to about $30,000 and $40,000, were awarded to Williams, Upham & Co. Work will not be begun until the spring.—Williams, Upham & Co have the contract for dredging 65,000 cu. yds. in Grand Marais harbor, at 24 cts. per cu. yd. C. S. Barker has the contract for dredging 278,000 cu. yds. in Superior harbor at 14 cts. per cu. yd.

Dredging.—These proposals were opened Nov. 20 by Lieut. G. J. FIEBEGER, U. S. Engineer Office, Norfolk, Va.: In approach to Norfolk harbor; P. Sanford Ross, Jersey City, N. J., 12⅛ cts. per cu. yd.; American Dredging Co., Philadelphia, Pa., 12⅞ cts.; National Dredging Co., Wilmington, Del., 12⅞ cts.; Morris & Cummings Dredging Co., New York, 13½ cts.; Atlas Dredging Co., 13⅞ cts.; Geo. C. Fobes & Co., Baltimore, Md., 14½ cts.—In Norfolk harbor; Morris & Cummings, 13 cts.: P. Sanford Ross, 13½ cts; American Dredging Co., 13½ cts.; Geo. C. Fobes & Co., 16 cts.

Metal Markets.—*Structural Iron.*—Prices are about as follows: in Philadelphia, 2.05c. @ 2.10c. for bridge plate; 2c. @ 2.10 c. for angles; 2.6c. @ 2.7c. for tees, and 3.3c. for beams and channels, iron or steel. Store prices are as follows in Chicago: angles, 2.35c. @ 2.50c.; tees, 2.60c. @ 2.70c., beams, 3.80c. Mill orders are taken at the following rates, f. o. b. Chicago: Angles, 2.15c. @ 2.20c.; universal plates, 2.25c. @ 2.30c.; tees, 2.55c. @ 2.65c.; beams and channels, 3.40c. New York prices are: sheared plates, 2c. @ 2.1c.; universal mill plates, 2.1c. @ 2.2c.; angles, 2.1c. @ 2.15c.; tees, 2.5c. @ 2.6c., channels and beams, 3.3c.

Steel Rails.—New York, $27.50 @ $28. Pittsburg, 28 @ $28.50. The event of the week has been the placing of the greater part of the order of the Pennsylvania Railroad; three Pennsylvania mills on the line of the road receiving each 15,000 tons, with the important proviso that they may deliver the rails at any time during the winter. It is stated that the rails were placed at $28 at mill, a figure which the trade regards as somewhat high, considering the market of the past few weeks. A sale of 2,000 tons for the Pacific coast was $2 under the price at which English rails were offered, delivered, so that at a lower rate of duty the domestic mill would have been crowded out, even on the basis of the low price of $27.50 at Eastern mill. According to the report of the Board of Control, the deliveries up to Nov. were 1,029,179 tons, the sales for 1888 delivery being 1,250,740 tons. For 1889 the sales are reported at 116,180 tons up to Nov. 1, but at least 150,000 tons have been placed since then.

Railway Track Supplies.—Pittsburg, Pa. Spikes, 2.20c., 30 days, delivered; splice bars, 1.85c. @ 1.90c.; track bolts, 2.85c. with square, and 2.95 with hexagon nuts.

Pipe Works.—The Oregon Iron & Steel Co., of Portland, Ore., is manufacturing cast-iron pipe and special castings. The company has a contract to supply the Spring Valley Water Co., of San Francisco, Cal., with pipe and specials for 4 years, and has also contracts for water pipe for Seattle, Wash. Ty., and Portland.

Court House.—The following proposals for the foundation and basement of the city hall and court house have been received at Minneapolis, Minn.: B. Aronson, Mankato stone, $115,908.28; Ring & Tobin, Kettle river stone, $158,271.06; McMullen & Co., Mankato stone, $189,300; H. Downs & Co., Mankato stone, $162,972.

Mineral Wool.—In the new cars for the express trains of the New York & New England R. R., all the hollow spaces of the floor, roof and sides are filled with mineral wool, which was adopted as being the best material for deadening sound and insulating the car from the outside temperature.

Well Cover.—The following bids for the construction of the covering of the water-works well at Winona, Minn., have been received by engineer FELLOWS: Canton Bridge Co., Canton, O., $1,695; J. C. Schneider, Winona, $2,500. The contract was awarded to the Canton Bridge Co.

Water Pipe.—The following proposals per gross ton for cast-iron pipe, have been received by the Board of Works, Jersey City, N. J.: At Morgan St. dock; Thos. J. McKenna, $27; Donaldson Iron Co., $28.25; John Fox, $28.50. At Communipaw Sta.; $27, $27.25, $28. Informal bids were presented by the McNeal Pipe & Foundry Co. and the Warren Machine Co. The contract was awarded to T. J. McKenna.

Viaduct.—*Albany, N. Y.*—Proposals for the construction of the Hawk St. viaduct have been received from the following firms: Boston Bridge Works, Boston Mass.; Wallis Iron Works, New York; Post & McCord, New York; New Jersey Steel & Iron Co., Trenton, N. J.; Edge Moor Iron Co., Wilmington, Del.; Groton Bridge Co., Groton, N. Y.; Hilton Bridge Co., Albany, N. Y.; King Bridge & Mfg. Co., Cleveland, O.; Penn Bridge Co., Beaver Falls, Pa.; Rochester Bridge Co., Rochester, N. Y.; Mt. Vernon Bridge Co., Mt. Vernon, O.

Sea-Wall.—The Harbor Commissioners, San Francisco, Cal., have received the following proposals for the construction of Section No. 8 of the sea-wall: San Francisco Bridge Co., $128,976; George D. Nagle, $126,000; John Kelso, $136,200; American Bridge & Building Co., $133,450; Pacific Bridge Co., $138,250; J. S. Antonelli, $118,688; Hoffman & Bates, $138,220; Rudolf, Axman & Co., $135,488; San Francisco Contracting Co., $148,878; B. McMahon & Son, $135,987; M. J. Kelly & John Hackett, $164,987; John W. Farish, $131,366.40. The contract was awarded to J. S. Antonelli, who has built a considerable amount of railroads on the Pacific coast.

Bridges.—*Brattleboro, Vt.*—The Berlin Bridge Co., of Berlin, Conn., has the contract for the new bridge across the Connecticut river for the commissioners of Brattleboro and Chesterfield. It will be a suspension bridge of about 300 ft. span. The cost will be about $13,000, of which Chesterfield will pay $8,000.

Centerville, Mass.—The King Iron Bridge & Mfg. Co., of Cleveland, O., has the contract for the new iron bridge. Work is to be completed by Dec. 19.

Newark, N. J.—The following proposals have been received for the new bridge over the Passaic at Clay St.; Riverside Iron Bridge Co., Paterson, N. J., $74,869; B. M. & J. F. Shanley, $83,950; Smith Bridge Co., of Toledo, O., $87,500; King Bridge & Mfg. Co., Cleveland, O., $92,000; Wallis Iron Works, $93,405; Ross & Sanford, Jersey City, N. J., $95,460; Penn Bridge Co., of Beaver Falls, Pa., $99,780; Dean & Westbrook, $110,000. The contract was awarded to the Riverside Iron Bridge Co. JAS. OWEN, of Newark, is the Engineer. There will be 2 fixed spans of 66 ft., and a draw span of 195 ft. to be operated by steam; roadway 30 ft. wide, with two 5 ft. sidewalks. The foundation piles are to be driven until a 20 ft. fall of the hammer will not drive them more than 6 ins.

St. Leonard, Que.—The Dominion Bridge Co., of Lachine, Que., has a contract from the Drummond County Ry. Co. for the construction of two bridges over the two branches of the Nicolet river, near St. Leonard, P. Q., one being 160 ft. through span, 34 ft. above the river, and the other having three 110 ft. deck spans, and 280 ft. of girder spans of 30 to 60 ft. each, supported on steel trestle work, about 75 ft. above the river. The cost of the two bridges will be about $65,000.

Dredging, Bridge, Etc.—Bids for three pieces of state work have been opened by JAMES SHANAHAN, Superintendent of Public Works, Albany, N. Y. Only $15,000 was appropriated for the improvement of the Seneca river and Old Bear race at Waterloo, and the one bid received was from O. J. Jennings, of Fulton, for $29,890. No award was made. Two proposals were received for contracting and depressing an iron culvert under the Erie canal in Rochester; from Chambers & Casey, Rochester, for $2,807.46; Valentine Brown, Mohawk, for $2,911.04. As the appropriation is only $3,000 the matter was not decided. The contract for building a bridge over the Glens Falls feeder at Ferry Street, Sandy Hill, was awarded to James E. Flood, of Sandy Hill, at $1,863,80. The only other bidder was Daniel Sturtevant, of Sandy Hill, at $2,361.75. The appropriation is $2,500.

Canals.—The contracts for the enlargement of the Cornwall canal have been awarded by the Dominion Government to Davis Bros., of Ottawa, for Sections 2, 3, 4, at about $1,000,000; and to the Gilbert Blasting & Dredging Co., of Montreal, for the summit section, at about $600,000.—The contract for the construction of the Sault Ste. Marie canal has been awarded to Hugh and John Ryan, of Toronto and Brockville. Associated with them are M. J. Haney & Co., of Watertown, N. Y. The amount of the contract is $1,200,000.

Sewer Pipe.—*Charleston, S. C.*—The Superintendent of Streets has awarded the contract for terra cotta pipe to the Rochester Sewer Pipe Co., of Rochester, N. Y., for 18-in., and to Montague & Co., of Chattanooga, Tenn., for 15-in. and 12-in.

Fresno, Cal.—The following are the prices of the contract awarded to the California Sewer Co., as noted last week; 18-in. pipe, 97 cts.; 16-in., 94 cts.; 14-in., 72 cts.; 12-in., 54 cts.; 10-in., 43 cts.; 8-in., 32 cts.; 6-in., 26 cts.; concrete, 50 cts.; lumber, $22 per M; manholes, $75 each; inspection holes, $10 each; flush tanks, $85 each; flume, 80 cts. per ft.; entire system, $46,119.40; entire pipe system, $30,807.40. J. C. DAILY is president of the company.

Sewers.—*Troy, N. Y.*—The Contract Board has awarded to J. H. Cavanaugh the contract for a tile sewer at $2.90 per lin. ft.

Albany, N. Y.—The Board of Contract & Apportionment has awarded the contract for a pipe drain to John L. Galoogly as follows: 8-in. pipe, $1.25 per ft.; Y branches, $2 each; receiving basins, 60 cts. each; 6-in. pipe, 75 cts. per ft.

Jersey City, N. J.—The Board of Public Works has received bids at the following prices: Receiving basins, $50 to $85 each; 12- in. pipe, 70 cts. to $2 per lin. ft.

Kansas City, Mo.—A sewer contract has been awarded to John Shaw at 75 cts. per lin. ft. for pipe, 50 cts. each for manholes, $18 per M. for lumber, 10 cts. per cu. yd. for rock excavation.

Street Work.—*Jersey City, N. J.*—The following are the prices of bids recently received by the Board of Public Works: Earth excavation, 16 to 30 cts. per cu. yd.; rock excavation, $1.30; earth filling, 1 ct. to 20 cts.; beach sand or gravel filling, $1 to $1.60; paving, $1.19 to $1.65 per sq. yd.; curbing, 46 to 60 cts. per lin. ft.; bridge stone, 40 to 75 cts. per sq. ft.; flagging, 17 to 19 cts. per sq. ft.

Louisville, Ky.—Contracts have been awarded as follows: H. A. Meyers, excavation, 15 cts. per cu. yd.; embankment, 35 cts.; curbing, 80 cts. per ft.; setting flagstones, 70 and 85 cts.; paving, $7.75 and $8.50 per sq. yd.; sidewalk, 58 cts. per sq. yd.; J. R. Gleason, excavation, 25 cts.; curbing, 70 cts.; flagging, 85 cts.; paving, $8. Jacob Gast, excavation, 22 cts.; curbing, 76 cts.; corner stones, $3; crossings, $2.90 per ft.; paving, $12.30. M. Gleason, sidewalks, 50 and 52 cts. per sq. yd. Humptick & Bronger, sidewalks, 57 and 60 cts. per sq. yd.

Kansas City, Mo.—Contracts have been awarded at the following prices: paving, $1.31 to $3.44; excavation, 13½ cts. per cu. yd.; embankment, 28 cts.

Sewers.—*Roanoke, Va.*—The following proposals have been received by J. H. SKINKER, City Engineer: Sexton & Houston, Roanoke, $6,703.14; T. H. Vaughan & Co., Roanoke, $6,890.64; B. J. Coyle, Washington, D. C., $9,737.95. The contract was awarded to Sexton & Houston, at the following prices: for laying 3,675 ft. of 24-in., 4,750 ft. of 12-in. and 4,665 ft. of 8-in. pipe, 14, 10 and 7½ cts. per lin. ft.; for 10,553 lin. ft. of excavation and backfilling under 6 ft., 1,640 ft. of 6 to 8 ft. and 800 ft. of 8 to 10 ft., 9 cts., 11½ cts. and 13½ cts. per lin. ft.; for 8,175 ft. of rock trench per ft. in depth, 26½ cts. per lin. ft.; for 50 lin. ft. of repaving, 4½ cts. per lin. ft.; 30 manholes, $35 each; 30 lamp holes $2; 6 flush tanks, $45; 2 tons of iron pipe, laid with lead joints, $40 per ton; 105 cu. yds. rock work (cement masonry), $4.50 per cu. yd.;

Pine Bluff, Ark.—The following was the only proposal received Nov. 10, and the contract was awarded to the bidder, his price being below the engineers' estimate: Wm. J. Irwin, Greenville, O.; pipe sewers, including excavation and back-filling, 18-in., $1.61 per lin. ft.; 15 in., $1; 12-in., 65 cts.; 10-in., 59 cts.; 8-in., 33 cts.; 6-in., 30 cts.: for each junction, in addition to the above prices, on 18-in., $3; 15-in., $2; 12-in., $1.50; 10-in., $1.20; 8-in., 80 cts.; 6-in., 60 cts.; manholes, up to 8 ft. deep, exclusive of ring and cover, $30; manholes per ft., $3.50 (to be added to or subtracted from price if depth is more or less than 8 ft.); flushing tanks, except ring and cover, $50 (the commissioners will furnish the Field patent syphon, ready to be set up, at cost, in Pine Bluff, of $30, if desired); 1-in. lead pipe flush tank connections with water mains, including tapping mains, 65 cts. per ft.; for each foot in height of hand holes on 18, 15, 12, 10, 8 and 6-in. pipe, $1, 70 cts., 60 cts., 50 cts., 40 cts., 35 cts.; embankment, 75 cts. per cu. yd.; excavation, 60 cts. per cu. yd.; pine or cypress sheeting and bracing left in trenches, $17 per M.; cypress piling in foundations and outfall, 80 cts. per lin. ft.; concrete, $9 per cu. yd.; cypress timber in foundations and outfall $25 per M.; white oak timber, $25 per M; brick, $20 per 1,000; cast-iron rings and covers, set in place, 3¾ cts. per lb. E. G. TRUEHEART is City Engineer; J. K. HANEY, of Little Rock, is Consulting Engineer.

WATER.

St. Paul, Minn.—A party of officials and guests recently made a visit to the new high service reservoir north of Lake Como, about 4½ miles from the city. The reservoir has straight sides and semi-circular ends, it is 20 ft. deep and has a capacity of 16,000,000 galls. The basin is of concrete, faced with granite on the inner slopes. The elevation is 310 ft. above low water in the Mississippi and 80 to 220 ft. above different parts of the city. Work was commenced in May and is now nearly completed. At the bottom of the basin is a grating through which the water enters from and discharges into a 36-in. pipe. The principal object in building the reservoir was to equalize the pressure in the high-service system. The water comes from Lake Vadnais through a conduit 4 miles long into a terminal chamber near the pumping station at McCarron's lake. It is thence pumped into the distributing pipes. These pipes are sufficient to supply all the water needed in the high-service districts, and the reservoir is to be used, not to keep up a supply of water, but to relieve the pumps of the unequal strain as the result of unequal demands upon the system. Heretofore the duty of the pumps has been about 90,000,000 ft. lbs. per minute, but the system without the reservoir only required that there should be lifted half that amount; therefore nearly half the duty was lost, while the pumps were kept working night and day. With the reservoir to take the surplus water, the pumps will be run at full duty, and it will not be necessary to keep them going more than half the time. There being but one pipe at the reservoir for the ingress and egress of water, that pipe becomes an inlet pipe when the consumption of water is not equal to the supply from the pumps, and an outlet pipe when the consumption is greater than the supply. The reservoir, by this means, equalizes the pressure upon the pipes, which has heretofore varied from 40 to 100 lbs. to the square inch, and has been a severe strain upon them. The size of the reservoir at the water line is 300 × 500 ft. The embankments are 90 ft. thick at the base, with an interior and exterior slope of 1½ : 1, and the parapet is 12 ft. wide. About 5,000 cu. yds. of concrete were used in the structure, and upwards of 50,000 cu. yds. of puddle. The total cost, including construction, pipes, valves, engineering and inspection, will be about $150,000. It was designed by J. T. FANNING, of Minneapolis, and H. H. HARRISON, of Stillwater. J. B. HAWLEY, engineer of the Water Board, has been in charge of construction. McArthur Bros. were the contractors.

Electric Light and Gas.—***Bangor, Me.***—It is proposed to put in 130 arc lights, operated by a plant at the dam. The cost is estimated at $17,000, and the maintenance at $32.30 for lamp per year.

Cherryfield, Me.—The Cherryfield Electric Light Co. has been organized, with a capital stock of $7,000. President, W. M. NASH; Treasurer, J. W. COFFIN, Jr.

St. Johnsbury, Vt.—The Thomson Houston Co. has a contract for a plant of 40 arc lights and 500 incandescent lights. The dynamos will be driven by water power.

Everett, Mass.—The town has made a contract with the Malden Electric Co. for lighting the streets next year and extending the system; $5,000 have been appropriated.

Athol, Mass.—The gas and electric light plants are to be located together, and the latter will be run by steam instead of by water power as at present.

Kingston, N. Y.—A new electric light company has been organized. Capital stock, $50,000.

Lansingburg, N. Y.—The Union Electric Light & Power Co. proposes to put in 160 incandescent and 30 arc lights.

Albion, N. Y.—The trustees are considering the electric light question and a local company is to be organized.

Athens, Tenn.—The Athens Mining & Mfg. Co. is interested in a scheme to build gas works.

Natches, Miss.—The city has awarded a five years contract to the Thomson Houston Co. at $85 per light per year for electric light.

Brainerd, Minn.—The city has awarded a contract for building the power house for the electric light plant and putting in the water wheel at the dam.

Duluth, Minn.—The council has passed a resolution authorizing the Committee on Light and Water, and the president, to visit other cities and investigate the matter of lighting the city by electricity.

Red Wing, Minn.—The Red Wing Gas & Electric Light Co. has awarded to the Northwestern Construction & Supply Co., of St. Paul, a contract for introducing the Westinghouse alternating system and making improvements in the present plant.

Waupaca, Wis.—The Electric Light Association has decided to rebuild the dam which was wrecked some weeks ago, and put the light plant in operation again. The work will cost between $5,000 and $6,000.

Kenosha, Wis.—The Kenosha Gas, Electric Light & Fuel Co. has been incorporated by J. H. KIMBALL, E. M. KIMBALL and E. S. HAMILTON. Capital stock, $50,000.

Menasha, Wis.—Eastern parties propose to put in an electric light plant with 100 arc lights and a number of incandescent lights for house lighting.

Helena, Mont.—The Helena Electric Light Co. put its plant in operation on Nov. 10. There is one 150 H. P. Corliss engine and 1 boiler, with 5 dynamos, but there are to be 3 engines when the plant is complete. President, E. W. KNIGHT; General Manager, WM. HARRISON.

Gainesville, Tex.—The Gainesville Gas & Coal Co. has changed its name to the Gainesville Light & Fuel Co. and will put in an electric light plant.

Dallas, Tex.—The city council has let the contract for fifty all night 2,000 arc lights for street lighting, the contract to run 3 years, with the right of the city to increase the number at any time. Each light to cost $83.95 a year.

Mitchell, Ont.—The Ball Electric Lighting Co. has closed a contract with the town for 35 lights to be supplied at once. This number will be increased in the spring.

Galt, Ont.—The council has decided to enter into an agreement with the gas company to light the town for the period of 3 months at the rate of 22½ cts. per light per night (midnight service).

New Orleans, La.—The city has been discussing the repudiation of the present contract with the water-works company, a suit over which contract is now before the courts to decide whether it can be repealed. The *Times Democrat* says: "We can scarcely conceive of greater or more injurious folly than this—the repudiation of a contract upon which the courts may pass any day, and will pass on at once if the city asks it; repudiation by a town, already in financial trouble, and suffering more than any other in the Union from a carelessness and recklessness in financial affairs, from a disregard of contracts, and from damage and other suits that have resulted therefrom. New Orleans has suffered in the past and will suffer more in the future, if it departs one step from the straight and honest policy of abiding by its contracts until the courts declare them to be illegal or repealable. It cannot afford to take the law into its own hands, and say: 'I won't wait for the courts, but will decide the matter to suit myself.' And least of all can it afford to do so in a case like that of the water-works contract, where its action is virtual repudiation and will prejudice its reputation for honesty."

The terms of the contract, which was made by a former council, are claimed to be unreasonable.

Portland, Ore.—Superintendent SMITH has made a report on the cost of a water supply of 15,000,000 galls. per day from Bull Run.* The headworks on Bull Run are 449 ft. above the principal reservoir in the City park. The length of pipe required is 30.63 miles, including 2,100 ft. of cast-iron pipe across and under the Willamette river. From the headworks the grades are 6.08 ft. to the mile for 10.25 miles, and 18.96 for the remainder of the distance. To carry 15,000,000 galls. a diameter of 35 ins. on the low grade and 28 ins. on the steep grade will be required. The weight of the wrought-iron pipe is estimated as follows:

	Ft.	Lbs.
Of 35-in. pipe	54,140	3,269,234
Of 28-in. pipe	105,500	4,837,608
Total.	159,640	8,142,842

The estimate of cost is as follows:

8,150,000 of pipe laid, at 8½ cts.	$ 692,750
Special manholes, extra joints, etc.	9,300
Excavating and refilling trench	78,000
Two submerged iron pipes	74,000
Total for pipes	$ 854,050
Three iron bridges across Sandy and Bull Run	14,300
Reservoir complete	45,000
Roads and clearing	9,600
Total for works complete	922,950
Ten pet cent. added	92,295
Total cost estimated	$1,015,245

Filter Plant.—The Jewell Pure Water Co. has erected a filtering plant for the Edison Lamp Co., Newark, N. J.

Water-Works.—***New Hampshire.***—Dover. Water was turned on Nov. 17, from the Cocheco Mfg. Co.'s pipes into the city water pipes.

Massachusetts.—Malden. The special commission on the extension of the water-works, has reported that it is inexpedient at present to construct a pumping station at Spot pond. The board has passed an order transferring $5,000 of the $15,000 appropriated for this purpose to the fund for the construction of water-works.——North Adams. Engineer A. W. LOCKE has commenced the survey for the new reservoir to supply the town with water from the Broad brook in Williamstown. He will also survey the route for the line of pipe.——Northampton. Supt. CLARK has put in a Jones' self recording water gauge.

New York.—Groton. The water-works are approaching completion.——Lockport. The new 3,000,000 galls. pumping engine will be ready for operation by Dec. 1.——Lansingburg. The water commissioners have concluded the sale of $25,000 in bonds issued for the construction of the new reservoir, to the Onondaga County Savings Bank, of Syracuse, at 112 and accrued interest from November 1 at 4 per cent.——Albany. Connection has been made between the water main from the Russell reservoir and the 24-in. main from Tivoli lake. The driven well tests are postponed till January 1.—— Greenport. The Greenport Water Co. has been incorporated by F. F. GORHAM, H. A. LOVELL, J. M. KALLEY, WM. C. SHEDDEN and J. H. RIEGER, of Brooklyn, and J. W. A. CRAIGHEAD, of Plainfield, N. J. Capital stock, $60,000.—— Islip. The St. Augustine Water Co. has been incorporated. Capital stock, $50,000.

New Jersey.—Moorestown. The Moorestown Water Co. is putting in check valves on its mains.

Maryland.—Centerville. Water-works are to be built; the supply will be taken from an artesian well and pumped to a stand-pipe. Bonds will be issued. Address W. F. HARMAN.

Ohio.—Findlay. The contractors have stopped work on the new water-works.——Westerville. Water-works are needed and projected. Address D. W. COBLE.—— Delaware. Moffett, Hodgkins & Clarke, of Watertown, N. Y., have begun building the water-works. Pipe and specials will probably be furnished by the Lake Shore Foundry, Cleveland, O.

Virginia.—Virginia Beach. The Princess Anne Hotel & Impt. Co. proposes to take its water supply from a small lake. There are no water-works.

Tennessee.—Dyersburg. The town has water-works but no fire apparatus.——Tullahoma. Water-works have been talked of, but no action has been taken.——Chattanooga. The water company will lay 10 miles of mains on extensions, and will put in additional pumping plant and filters.——Nashville. Work is in progress on the new reservoir, and the new mains will soon be received.

Kentucky.—Harrodsburg. Water-works are projected but are not yet built. They will be built by the Harrodsburg Water Co., not yet fully organized; President, G. H. GAITHER. The present supply is from wells and cisterns; it is proposed to pump water from the river, 1¼ miles distant, to a stand-pipe. Estimated cost, $50,000 to $60,000. Capital stock of company, $100,000. Population, 2,200.

South Carolina.—Columbia. The city engineer is preparing plans for the new 5,000,000 galls. reservoir.

Georgia.—Washington. Water-works have been proposed but the proposition has not yet met with any success. Population, 3,000. For particulars address T. BURWELL GREEN.

Michigan.—Pontiac. The works are nearly completed. They will cost about $90,000.—— Greenville. There will soon be 6 miles of mains in use.

Indiana.—Indianapolis. The water company, since the investigation by the Council, has laid nearly 25,000 ft. of mains, on the order of the Council, and 9,000 ft. on the request of citizens, has added two engines, of 350 H. P., built a stone wall 400 ft. in length at the gallery, for protection of that work, and made a new filtering gallery about 50 ft. long.

Illinois.—Chicago. To prevent future trouble from fish in the mains, the inlet at the crib will be fitted with 3 screens, instead of 1 as at present, so that one can be cleaned at a time without opening the inlet.——Springfield. The work of putting in the connecting pipes and valves between the well and the pumps at the water works station is about completed.—— Pekin. The mains will be extended 3,200 ft.——Venice. The bids for water-works were referred to Architect LUCAS PFIFENBERGER, of Alton, Ill., who was instructed to close the contracts with different parties. The aggregate amount was $8,000.

Missouri.—Washington. John MAXWELL, the contractor for laying the 4½ miles of mains, has completed his work. The reservoirs are being lined with brick and cement. The water company has received two compound, duplex, plunger pumps from the Pond Engineering Co., of St. Louis. The city has by ordinance set apart $3,000 from the general revenue fund for paying the Interstate Gas & Water-Works Co., that being the sum due to the company annually.

Kansas.—Lawrence. The water company is now furnishing a good quality of water.

Nebraska.—Lincoln. The Water Board has ordered a vertical pumping engine from the Deane Steam Pump Co., instead of the horizontal one previously ordered. The Antelope well is furnishing 300,000 galls. per day.—— O'Neil. Water-works are projected. Address Dr. A. M. MORRIS.——Greeley. The city council has decided to issue bonds for water-works at Greeley Center.

Montana.—Helena. In the injunction case to restrain the council from paying the Woolston company's bills, the judge has decided that the city should advertise for bids for a water supply, pursuant to the charter; but that, until it does so, it is liable to the company for the time it has furnished water at the rate agreed on in the original contract. The city clerk was ordered to advertise at once for bids for furnishing the city with water for the ensuing year, and the bids were opened Nov. 21.

Oregon.—East Portland. The East Portland Water Co. is putting in a Worthington engine with a capacity of 1,440,000 galls. per day.

Texas.—Marble Falls. The Marble Falls Mfg. Alliance Co. is interested in a water-works scheme.—— Galveston. Well No. 7 is now down about 700 ft.

Canada.—Port Arthur, Ont. Engineer MALHIOT, acting for the water-works company, has made a traverse of McVicar's creek, has run a line from the creek to Current river, and is cross-sectioning both of them. The company would like to put in the upper dam this fall.

Nashville, Tenn.—City Engineer JOWETT has submitted his report for 1888. During the year 8,734 sq. yds. of granite paving were laid, 71,462 cu. yds. of grading, 1,577,868 bushels of macadam, 5,344 sq. yds. of bitumen brick paving, 77,374 b us,of sand and gravel, 12,972 ft. of curbing, 12,892 sq. yds. of guttering, 14,004 sq. yds. of brick sidewalk, 2,369 ft. of crossing, 944 ft. of box culvert. The amount expended was $155,972.96. Of pipe sewers, 160 ft. of 4-in. earthenware pipe were laid, 516 ft. of 8-in., 2,918 ft of 10-in., 1,354 ft. of 12-in., 1,975 ft. of 15-in., 1,660 ft. of 18-in., 100 ft. of 21-in., 836 ft. of 24-in. Of brick sewers, 237 ft. of 36-in. diameter were constructed, 1,583 ft. of 42-in., 1,216 ft. of 54-in. A total of 12,548 ft. of sewer in all were laid or made, and the cost was $22,818.91. On the water-works there was expended $216,379.14.

The Mountain Spring Land & Water Co. has been organized at San Bernardino, Cal., to deal in land and water rights, and to supply water for irrigation and domestic purposes. The company proposes to pipe water from the mountains to its lands in the valley, and will establish one of the most extensive water systems in San Diego Co. President, BYRON WATERS; Vice President, JAMES FORQUEN; Secretary, B. W. SMITH; Treasurer, H. J. DEYO. Capital stock, $400,000.

Caribou, Me.—The Caribou Water Co. will construct works at Caribou, Me. Construction will begin May 1, 1889, and the works are to be completed by Sept. 1, 1889. The works will consist of stand-pipe, 3½ miles of 8-in. and 6-in. cast-iron mains, 25 hydrants, and pumps (water power) with a capacity of 1,000,000 galls. per 24 hours. M. M. TIDD, of Boston, is the company's engineer. No contracts have yet been made. The hydrant rental is $2,000 per year. All construction contracts will be made by H. M. HEATH, Treasurer, Augusta, Me.

The Willamette Falls Electric Co. has been incorporated at Portland, Ore., by D. P. THOMPSON, E. L EASTHAM, P. T. MOREY, R. H. THOMPSON, L. L. HAWKINS W. K. SMITH and J. C. MORELAND. Capital stock, $1,000,000. The company will supply electricity for illumination and power, operate telegraph lines and electric railways, etc.

Albany, N. Y.—The cost of the new driven well plant complete, including the cost of one additional 5,000,000-gall. pumping engine to be used in connection with the 3 engines of a similar capacity each, purchased by the old water commission, will aggregate about $375,000. Of this amount, $297,500 goes to Andrews Bros. for the plant. Other items of expense will include the building of the temporary and permanent engine house and coal house, costing in round figures about $30,000, and the conduit, an estimate for the construction of which has not been prepared. The new commission is authorized to expend $1,200,000. It is estimated that the West Albany plant will be fitted up in good shape for about $250,000. The Russell Road and Sand Creek reservoirs are about complete and by Dec. 1 a supply of 4,000,000 galls. daily of pure water, which is gathered in these reservoirs above the contaminating drainage of West Albany, will be turned into the city supply. The Sand Creek reservoir will hold about 8,000,000 galls, and the Russell Road reservoir over three times the amount, and this volume, together with that of the new Tivoli reservoir, having a capacity of 26,000,000 galls., there will be between 50,000,000 and 55,000,000 galls. stored in the three reservoirs to be used in case of emergency. All of the new reservoirs will be built so that they may be emptied, and cleansed without interrupting the city's supply. It is now suggested that a new reservoir be built on the city's property, west of the Bleecker reservoir, at a cost of about $60,000.

Irrigation.—***California.***—The Manzanita Water Co., to operate in San Mateo, Santa Clara and San Francisco counties, has been incorporated by ARIEL LATHROP, O. G. LATHROP and F. S. DOUTY, of San Francisco, and J. L. RATHBONE and WM. HARNEY, of Menlo Park. Capital stock, $1,000,000.

Texas.—Eagle Pass. The Eagle Pass Irrigation & Water-Works Co. has been incorporated to build canals for irrigation. President, W. T. ROBINSON; Secretary, P. W. THOMPSON; Engineer and Manager, W. O. TITUS Capital stock, $105,000.—El Paso. It is proposed to build a dam 60 ft. high across the Rio Grande to form a great irrigation reservoir. About 50,000 acres would be submerged. An engineer is to be engaged to report upon the scheme.

Special Reports of Water-Works Construction.

THE ENGINEERING NEWS MANUAL OF AMERICAN WATER-WORKS is now being compiled, and will be *indispensable* to every manufacturer, engineer and contractor in any way interested in Water-Works construction and maintenance, and will be of great value to Water-Works superintendents and projectors of new works.

Superintendents of water-works and water companies will wish to see correct and complete data concerning their Works in our MANUAL, and to ensure this they should send in reports *at once* upon the blanks which we have already sent to every Water-Works office in the United States and Canada. Many have delayed their report, and if the blanks we intended for them have been lost in the mail, or mislaid, we will send more upon request.

We *must* have a report from every public water supply system in North America, so those who reply to our inquiries at once will save a second inquiry. We also wish to know of *every* new Water-Works plant in process of construction, and of *every* new project in this line. We will send to any one desiring them, blanks upon which reports can be made.

Further details of the MANUAL will be advertised later. We abstract from our special reports for the MANUAL the following items of current interest:

HANCOCK, N. Y., Nov. 14, 1888.

EDITOR ENGINEERING NEWS:—Nothing has been done towards building water-works here except to organize the Hancock Water Co., the stock of which is not yet all taken. Nothing more will be done until next spring. GEO. COWAN, of Stamford, N. Y., is our engineer. The estimated cost of the works is $12,000.

G. A. ALLEN.

FRANKLIN, Ind., Nov. 16, 1888.

EDITOR ENGINEERING NEWS:—We wish to contract for water-works at an early date, so work will begin at the opening of spring. We want a company to put in the works, we paying an annual hydrant rental. We are favorably impressed with the stand-pipe system, which we shall probably want. Our population of 4,000 will require about 6½ miles of pipe, with from 65 to 70 fire hydrants. Any information will be thankfully received.

FRANK MCCOLLOUGH, *Chairman Water Com.*

TUSCALOOSA, Ala., Nov. 12, 1888.

EDITOR ENGINEERING NEWS:—The Tuscaloosa Water-Works Co. has completed the works begun Feb. 1, 1888, and will put them in operation the first of next year. The supply is from the Warrior river, by pumping to a tank placed on a tower. The contractors for the entire system were the Jeter & Boardman Gas & Water Assoc., of Macon, Ga., A. E. BOARDMAN being the engineer. There is a Worthington pump with a daily capacity of 2,000,000 galls. a 135,000-gall. stand-pipe, 120 taps, no meters and 50 hydrants. The pipe and specials were furnished by R. D. Wood & Co., Philadelphia, Pa., the mains being cast-iron, and the services, galvanized iron. Mathews hydrants and Eddy valves are used. The ordinary pressure is 50, and the fire 100 lbs. The works cost $106,000; the capital stock is $75,000, and the bonded debt, $50,000, at 6 per cent. interest. The franchise is for 30 years, and the hydrant rental is $50 each. The officers of the company are: President, J. W. WILCOX; Secy., W. P. FITTS; Treas., A. E. BOARDMAN, Macon, Ga.; Supt. W. Y. TODD.

A. E. BOARDMAN.

BATON ROUGE, La. Nov. 6, 1888.

EDITOR ENGINEERING NEWS:—Water-works were completed here this month by the Baton Rouge Water Co. Smedley & Woods were the builders. L. P. AMISS.

208 S. 4TH ST., PHILADELPHIA, Pa., Nov. 14, 1888.

EDITOR ENGINEERING NEWS: The Bristol-Goodson Water Co. will begin supplying Bristol, Tenn., and Goodson, Va., with water Dec. 20. Water is pumped from a large limestone spring to a tank on a tower. There are two 750,000 gall. Silsby pumps, and the tank has a capacity of 100,000 galls. There are 5½ miles of cast-iron mains, the services are of galvanized iron, and the pipes and specials were furnished by the South Pittsburgh (Tenn.) Pipe Works. Taps are now being made. There will be about 35 Taylor hydrants, and the valves are furnished by W. S. Payne & Co. The ordinary pressure will be 75, and the fire, 110 lbs. The company has a capital stock of $75,000, and $40,000 of 6 per cent. bonds. The contract for hydrants provides a rental of $40 each for the first 25, and $35 for all others. The officers of the company are: President, SAML. L. KING; Secretary, B. G. MCDOWELL; Treasurer, B. HUBBELL. The first two are of Bristol, Tenn., and the last one of Baltimore, Md. The population of each place is estimated to be 3,500.

W. W. TAYLOR,
Engr. and Contr. for the Co.

CENTRAL CITY, Ky., Nov. 12, 1888.

EDITOR ENGINEERING NEWS:—The Central City Water Co. has been formed, but no officers have been elected. Probably work will be begun next spring. Water will be pumped from Green river to a stand-pipe and reservoir, there will be 2¾ miles of pipe, and the capital stock of the company will be about $25,000. T. CAW PENT.

NICHOLASVILLE, Ky., Nov. 12, 1888.

EDITOR ENGINEERING NEWS:—Water-works have been discussed by our citizens for some time. For information address J. S. BRONAUGH, Mayor. W. J. DUNMAN.

DANBURY, Conn., Nov. 10, 1888.

EDITOR ENGINEERING NEWS:—The Pineville, Ky., Water Co. has completed its reservoir, is now laying pipe, and expects to have its works in operation by Jan 1, 1889. The company has a perpetual franchise, with a hydrant contract for 15 hydrants at $15 each. The officers are: President, F. A. HULL, Danbury, Conn.; Vice-President and General Manager, J. S. RAY; Treasurer, M. J. Moss, and Secretary, D. N. MASON; EMIL MAHLOO is Engineer; Cosgrove & Co., Pineville, contractors for masonry and reservoir. The pipe and specials are furnished by Dennis Long & Co., Louisville, Ky., and trenching and pipe-laying done by Nichols & Co., Burgin, Ky. Mathews hydrants and Ludlow valves are used, and there will be no meters at first.

The supply is from Bird's branch, by gravity to a distributing reservoir 40 ft. sq. and 20 ft. deep. There will be 5 miles of from 8 to 4-in. mains, 20 hydrants, an ordinary pressure of 70, and a fire, of 80 lbs. The works will cost $20,000, and there is $12,500, each, of stock and bonds. The annual operating expenses will be but $200, and the revenue about $1,200 from consumers and $300 from city. The population is $1,200. F. A. HULL.

MACOMB, Ill., Nov. 14, 1888.

EDITOR ENGINEERING NEWS:—There has been considerable outside talk about water-works, but the city has not taken action on the matter. I think it likely that something will be done the next year, but cannot say positively. WM. E. MARTIN, *Mayor.*

NASHVILLE, Ark., Nov. 13, 1888.

EDITOR ENGINEERING NEWS:—A pump was bought over a year ago and placed in a steam mill. It was proposed to pump water to a reservoir and stand-pipe, but owing to litigation the growth of our town has stopped, and until the trouble is settled nothing will be done towards completing water-works. A private company was to build the works, but it was never fully organized. Population, 1,500. F. W. LEE.

PHŒNIX, Cal., Nov. 8, 1888.

EDITOR ENGINEERING NEWS:—J. J. Gardiner and Son have just begun to build water-works here, and are now erecting machinery. HALL.

PORTERSVILLE, Cal., Nov. 8, 1888.

EDITOR ENGINEERING NEWS:—The town is preparing for water-works. E. NEWMAN will give all necessary information concerning them. POSTMASTER.

PASADENA, Cal., Nov. 8, 1888.

EDITOR ENGINEERING NEWS.—There are several water companies in Pasadena, the three principal ones being: Pasadena Lake Vineyard Land & Water Co.; Pasadena Land & Water Co.; and North Pasadena Water Co. All are incorporated and managed by directors for the stockholders. T. HABBICKS

Secy., Pasadena Lake Vineyard L. & W. Co.

RECORD OF NEW WATER-WORKS CONSTRUCTION.

(Specially Communicated).

CONTINUED FROM PAGE 398.

Holdrege, Neb.—The works were commenced Feb. 1, 1888, and were first operated Aug. 13, 1888. At the date of our special report, Oct. 25, 1888, the works were all completed except erecting the stand pipe on the foundation, the latter being already built. They were designed by A. A. RICHARDSON, of Lincoln, Neb.; BEN. S. CLARKE was Constructing Engineer, and took the contract for the work. The other contractors were as follows: for masonry and foundations, T. E. Farrell, Hastings, Neb.; for buildings, Morton Johnson, of Holdrege, and A. L. Metcalf, of Lincoln; for pumping machinery and boiler, Pond Engineering Co., St. Louis, Mo.; for pipe and specials, Chattanooga Foundry & Pipe Co., Chattanooga. The Adams hydrants and Ross valves are used. The supply is taken from two wells 200 ft. deep, with 60 ft. of water in each well. The system is combined direct pressure and pumping to stand-pipe. The reservoir is 46 ft. x 36 ft. and 10 ft. deep; the stand-pipe is 15 ft. diameter by 110 ft. high. The pumping plant consists of one high pressure pump of 1,500,000 galls. capacity, one low pressure pump of 1,000,000 galls. capacity, and two vertical pumps 12 x 36. There are over 4 miles of pipe, 52 hydrants, and about 50 taps; no meters; the mains are of cast-iron and the services of lead and galvanized iron. Ordinary pressure, 80 lbs.; fire pressure, 130 lbs. Cost of works, $62,000; debt, $30,000; rate of interest on bonds, 5½ per cent. The annual revenue from the city is $3,380; from consumers, estimated at $4,000 when works are completed. The stand-pipe was erected by John Gubbins, Excelsior Machine & Boiler Works, Chicago. The franchise is for 20 years; and the hydrant rental is $65 per hydrant per annum. The works are owned by the Holdrege Water Co.; President, C. THOMPSON; Secretary, Treasurer, Manager and Superintendent, BEN. S. CLARKE. Capital stock, $62,000; bonds, $45,000. Present population, 3,200. (Date of special report; Oct. 25, 1888).

Waynesburg, Pa.—The works were commenced Aug. 1, 1887, and completed about June 1, 1888. The engineers were JAMES H. HARLOW & CO. By February water was supplied direct, the reservoir not being finished. The pumping plant was furnished by Smith & Vaile, of Dayton, O.; the pipe and specials by R. D. Wood & Co., Sayre Pipe Co. and Jackson & Woodin Mfg. Co.; the Holyoke valves and hydrants are used. The water is taken from Ten-Mile run and pumped to a reservoir with a capacity of 1,000,000 galls. by 2 pumping engines of 300,000 galls. and 800,000 galls. daily capacity; there are 2 steel tubular boilers 12 ft. x 4 ft. There are about 4 miles of pipe, 28 hydrants and 25 taps; the mains are of iron and the services of lead and iron. Average ordinary and fire pressure, 125 lbs. The cost, up to February, was $75,000; debt, $25,000 in bonds, of which only $12,000 had been issued; rate of interest, 6 per cent. The hydrant rental is $50 per annum. The works are owned by the Waynesburg Water Co.; President, WM. POLLOCK; Treasurer, J. D. SINGLEY; Secretary and Superintendent, L. N SINGLEY. Capital stock, $50,000; bonds, $25,000. The present population is 2,500.

(TO BE CONTINUED).